Federal Aviation Administration – Regulations and Policies
Aviation Rulemaking Advisory Committee

Transport Airplane and Engine Issue Area
Powerplant Installation Harmonization Working Group

Task 5 – Powerplant Fire Mitigation Requirements

Task Assignment

[Federal Register: September 23, 1998 (Volume 63, Number 184)]
[Notices]
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DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

Aviation Rulemaking Advisory Committee; Transport Airplane and Engine Issues--New Tasks

AGENCY: Federal Aviation Administration (**FAA**), DOT.

ACTION: Notice of new task assignments for the Aviation Rulemaking Advisory Committee (ARAC).

SUMMARY: Notice is given of new tasks assigned to and accepted by the Aviation Rulemaking Advisory Committee (ARAC). This notice informs the public of the activities of ARAC.

FOR FURTHER INFORMATION CONTACT: Stewart R. Miller, Transport Standards Staff (ANM-110), Federal Aviation Administration, 1601 Lind Avenue, SW., Renton, WA 98055-4056; phone (425) 227-1255; fax (425) 227-1320.

SUPPLEMENTARY INFORMATION:

Background

The **FAA** has established an Aviation Rulemaking Advisory Committee to provide advice and recommendations to the **FAA** Administrator, through the Associate Administrator for Regulation and Certification, on the full range of the **FAA**'s rulemaking activities with respect to aviation-related issues. This includes obtaining advice and recommendations on the **FAA**'s commitment to harmonize its Federal Aviation Regulations (FAR) and practices with its trading partners in Europe and Canada.

One area ARAC deals with is Transport Airplane and Engine Issues. These issues involve the airworthiness standards for transport category airplanes and engines in 14 CFR parts 25, 33, and 35 and parallel provisions in 14 CFR parts 121 and 135.

The Tasks

This notice is to inform the public that the **FAA** has asked ARAC to provide advice and recommendation on the following harmonization tasks:

Task 5: Power Plant Fire Mitigation Requirements

Specific Tasks--Phase I
1. Rule Harmonization
(a) JAR 25.1183 has a (c) paragraph that adds the requirement for

components to be fireproof where, if damaged, fire could spread or essential services could be adversely affected.

(b) FAR/JAR 25.1187, 25.1189(a) and 25.1193(c) are considered equivalent--no harmonization is required.

2. Advisory Material (AC/AMJ) Harmonization

(a) FAR 25.1187--Drainage and Ventilation of Fire Zones. **FAA** regulation requires the provisions for flammable fluid drainage, including the drainage path and drainage capacity, be demonstrated to be effective under anticipated conditions. Draft AC 25.1187, published for comments, describes the methodology to be used. **FAA** and JAA agreement on an acceptable means of demonstrating compliance is required. The Advisory Material to be developed should provide guidance on an acceptable means of demonstrating compliance for ``drainage of flammable fluids''.

(b) FAR 25.1189(a)--Shutoff Means. This paragraph requires shutoff valves to prevent a hazardous quantity of flammable fluid entering a fire zone following detection of a fire. The central issue to be resolved is associated with **FAA**/JAA agreement of the definition of ``hazardous quantity'' of flammable fluid. The working group should provide guidance to the **FAA** and JAA to define what is considered a ``Hazardous Quantity of Flammable Fluid'' when showing compliance to this regulation.

(c) FAR 25.1193(c)--Cowling and Nacelle Skin. **FAA** requires the nacelle be fireproof for 360 degrees, unless aerodynamic testing shows that fire exiting the nacelle poses no additional hazards to the airframe. JAA reportedly accepts 90 degrees (45 degrees from pylon centerline) without additional testing. JAA NPA proposes to provide guidance (JAA PNPA 25E-266). **FAA** and JAA should document current practices for use by Task Group consideration towards development of harmonized guidance regarding this subject. The Guidance Material to be developed should provide guidance on an acceptable means of demonstrating that the extent of fire proof cowling assures ``no additional hazard to the airframe'' for all types of transport category airplane engine installations.

The **FAA** expects ARAC to submit its recommendation(s) resulting from Phase I by November 30, 2000.

Specific Tasks--Phase II

1. Rule Harmonization

(a) Harmonize the definitions of the terms ``fire resistant'' and ``fire proof'' in FAR 1 and JAR 1.

2. Advisory Material (AC/AMJ) Harmonization

(a) Draft additional advisory material for 25.903(d)(1) related to minimizing the hazard associated with engine case burnthrough.

(b) Validate and harmonize the Fire Test Guidance Material in Paragraph 8 of AC 20-135 (may be transferred to be included in burnthrough advisory material).

(c) Validate and Harmonize the FAR/JAR Advisory Material for Engine Case Burnthrough and/or Related Engine Fire Test Guidance material such as an ISO standard.

The **FAA** expects ARAC to submit its recommendation(s) resulting from Phase II by April 1, 2001.

Task 6: Prohibition of Inflight Operation for Turbopropeller Reversing System and Turbojet Thrust Reversing System Intended for Ground Use Only

Recommend harmonized changes to FAR/JAR 25.1155 which would require a means to prevent the flight crew of turbine powered airplanes from inadvertently or intentionally placing the propellers into beta, deploying the thrust reverser while inflight, or otherwise commanding reverse thrust, unless the airplane has been certified for such operation. In addition to the harmonized rule recommendation, harmonized advisory material may also need to be developed in order to further standardize compliance with the recommended rule.

The **FAA** expects ARAC to submit its recommendation(s) resulting from this task by July 31, 2001.

Task 7: Powerplant Inflight Restarting

Review FAR 25.903(e) and corresponding JAR requirement related to inflight restarting and generate an amended harmonized requirement that provides a minimum engine restart capability within the airplane operating envelope following loss of all engine thrust. In addition, provide harmonized advisory material that defines the acceptable methods of compliance to the amended regulations. Both of these tasks should take into account and address:

1. Review of the service history.
2. Review of inherent starting capability of the engines at the time the original 25.903(e) rule was promulgated.
3. Alternative design means for restarting main engines.

The **FAA** expects ARAC to submit its recommendation(s) resulting from this task by July 31, 2001.

The **FAA** requests that ARAC draft appropriate regulatory documents with supporting economic and other required analyses, and any other related guidance material or collateral documents to support its recommendations. If the resulting recommendation(s) are one or more notices of proposed rulemaking (NPRM) published by the **FAA**, the **FAA** may ask ARAC to recommend disposition of any substantive comments the **FAA** receives.

Working Group Activity

The Powerplant Installation Harmonization Working Group is expected to comply with the procedures adopted by ARAC. As part of the procedures, the working group is expected to:

1. Recommend a work plan for completion of the tasks, including the rationale supporting such a plan, for consideration at the meeting of ARAC to consider transport airplane and engine issues held following publication of this notice.
2. Give a detailed conceptual presentation of the proposed recommendations, prior to proceeding with the work stated in item 3 below.
3. Draft appropriate regulatory documents with supporting economic and other required analyses, and/or any other related guidance material or collateral documents the working group determines to be appropriate; or, if new or revised requirements or compliance methods are not recommended, a draft report stating the rationale for not making such recommendations. If the resulting recommendation is one or more notices of proposed rulemaking (NPRM) published by the **FAA**, the **FAA** may ask ARAC to recommend disposition of any substantive comments the **FAA** receives.
4. Provide a status report at each meeting of ARAC held to consider

transport airplane and engine issues.

The Secretary of Transportation has determined that the formation and use of ARAC are necessary and in the public interest in connection with the performance of duties imposed on the **FAA** by law.

Meetings of ARAC will be open to the public. Meetings of the Powerplant Installation Harmonization Working Group will not be open to the public, except to the extent that individuals with an interest and expertise are selected to participate. No public announcement of working group meetings will be made.

Issued in Washington, DC, on September 17, 1998.

Joseph A. Hawkins,
Executive Director, Aviation Rulemaking Advisory Committee.

[FR Doc. 98-25469 Filed 9-22-98; 8:45 am]
BILLING CODE 4910-13-M

Recommendation Letter

— Effect for processing

Pratt & Whitney
400 Main Street
East Hartford, CT 06108

Pratt & Whitney
A United Technologies Company

January 17, 2000

AR #5

Department of Transportation
Federal Aviation Administration
800 Independence Ave, SW
Washington, D.C. 20591

Attention: Mr. Anthony Fazio, ARM-1

Reference: ARAC Tasking, Federal Register, November 26, 1999

Dear Tony,

At the December 1999 Transport Airplane and Engine Issues Group meeting, the Powerplant Installation Harmonization Working group presented a "Fast Track" report addressing 25.903(e), Inflight Starting. This report had been prepared in accordance with the reference tasking.

The 25.903(e) report submittal to TAEIG included a number of significant opposing views from PPIHWG members that had not been resolved. After extensive discussion it was concluded that returning the report to the Working Group at this time was unlikely to result in resolution of the differences. It was then concluded that the best course of action would be to forward the attached, 25.903(e) report with the minority opinions to the FAA for further processing into NPRM and draft Advisory Circular format. Following FAA completion of this activity, it is requested that in accordance with the "Fast Track" process that the package be returned to TAEIG for review with the PPIHWG in order to provide an opportunity to reach consensus.

Please feel free to contact me if additional information is required.

~~ANM-98-~~

63FR 50954

Sincerely yours,

C. R. Bolt

C. R. Bolt
Assistant Chair, TAEIG
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Attachment: Diskette
cc: Dorenda Baker – FAA-NWR*
Kristin Larson – FAA-NWR
Phil Sallee – Boeing*
Effie Upshaw – FAA - ARM
*letter only

Acknowledgement Letter

MAR 15 2000 *

Mr. Craig Bolt
Assistant Chair, Transport Airplanes
and Engines Issues Group
400 Main Street
East Hartford, CT 06108

Dear Mr. Bolt:

This letter acknowledges receipt of the following working group technical reports that you have submitted on behalf of the Aviation Rulemaking Advisory Committee (ARAC) on Transport Airplane and Engine Issues (TAE):

Date of Letter	**Task No.**	**Description of Recommendation**	**Working Group**
12/14/00	1, 2, 3	Fast track reports addressing §§ 25.703(a) thru (c) (takeoff warning system); 25.1333(b) (instrument systems; and 25.1423(b) (public address system)	ASHWG
12/17/00	5	Fast track reports addressing §§ 25.111(c)(4), 25.147, controllability in 1-engine inoperative condition; 25.161 (c) (2) and (4), and (e) (longitudinal trim and airplanes with 4 or more engines) 25.175(d) (static longitudinal stability; 25.177(a)(b) (static lateral-directional stability); 25.253(a)(3) (high speed characteristics); 25.1323(c) (airspeed indicating system); 25.1516 (landing gear speeds); 25.1527 (maximum operating altitude); 25.1583(c) and (f) operating limitations) 25.1585 (operating procedures); and 25.1587 (performance information)	FTHWG
12/17/00	7	Fast track report addressing § 25.903(e) (inflight engine failures)	PPIHWG

12/20/00	5	Fast track reports addressing §§ 25.1103 (auxiliary power units); 25.933(a) (thrust reverers); 25.1189 (shutoff means); 25.1141 (powerplant controls); 25.1093 (air intake/induction systems); 25.1091 (air intake system icing protection; 25.943 (thrust reverser system tests); 25.934 (negative acceleration); 25.905(d) (propeller blade debris); 25.903(d)(1) (engine case burn-through); 25.901(d) (auxiliary power unit installation; and 1.1 (general definitions)	PPIHWG
12/20/00	4	Fast track report, category 2 format--NRRM addressing § 25.302 and appendix K (interaction of systems and structures	LDHWG
12/20/00	2	Fast track report—(in NPRM/AC format) addressing §§ 25.361 and 25.362 (engine and auxiliary power unit load conditions)	LDHWG
12/20/00	1	Fast track report addressing § 25.1438 (pressurization and low pressure pneumatic systems)	MSHWG

The above listed reports will be forwarded to the Transport Airplane Directorate for review. The Federal Aviation Administration's (FAA) progress will be reported at the TAE meetings.

This letter also acknowledges receipt of your July 28, 1999, submittal which included proposed notices and advisory material addressing lightning protection. We apologize for the delay. Although the lightning protection task is not covered under the fast track proposal, the FAA recognizes that technical agreement has been reached and we will process the package accordingly. The package has been sent to Aircraft Certification for review; the working group will be kept informed of its progress through the FAA representative assigned to the group.

Lastly, at the December 8 - 9, 1999, TAE meeting, Mr. Phil Salee of the Powerplant Installation Harmonization Working Group indicated that the working group members agreed that § 25.1103 was sufficiently harmonized and that any further action was beyond the scope of task 8 assigned. We agreed with the TAE membership to close the task. This letter confirms the FAA's action to close the task to harmonize § 25.1103.

Recommendation

#57

A BETTER PLAN FOR HARMONISATION: PPSG REVIEW OF CAT 1 AND 2 ITEMS

This message gives the PPSG position on the Category 1 and 2 Harmonisation Items identified in the 4 June 1999 FAR/JAR-25 Differences List. In accordance with the 'Better Plan', specific Reports have been written to identify the Harmonisation issues. In most cases, the PPSG comments relate to the actual proposals given in the Report, rather than the background material. Where the term 'acceptable in principle' is used, this simply means that there has been insufficient time to discuss all the details of the proposal.

1. FAR 1/JAR-1 FIREPROOF/RESISTANT DEFINITIONS

The additional words, proposed to be added to the existing JAR-1 definitions to create the new Harmonised Definitions, given in paragraph 6 of the Report produced in Montreal at the 23 PPIHWG meeting are acceptable to the PPSG.

2. 25.901(d) APU INSTALLATION

Paragraph 6. The PPIHWG APU Task Group (TG) completed their work at least two years ago. Their proposal for the Subpart J (Appendix for FAR) is acceptable to the PPSG.

Paragraph 12. A review of the ACJ for JAR-25 Subpart J has lead to the deletion of two current ACJs - 25B903(e)(2) and 25A939(a). The remaining ACJs are considered not to add new requirements.

Paragraph 15. There are no known ICAO requirements for APUs - Airworthiness or Environmental.

3. 25.903(d)(1) ENGINE CASE BURN-THROUGH

Paragraph 6. The compliance section of the proposed AC/ACJ is based upon the JAA NPA 25E-257 and is acceptable to the PPSG in principle. At our recent PPSG meeting, there were two suggestions, which deserve attention, at least for the future, if not now:

(i) With current design capability, it should be possible to 'prevent' hazards rather than just 'minimise' them.

(ii) There is a good case to be made for divorcing the rotor burst and engine case burn-through requirements.

Paragraph 15. There are no known ICAO requirements for Engine case burn-through.

4. 25.903(e) RESTART CAPABILITY

Paragraph 6. The proposed AC/ACJ material has been revised to include the JAA comments, but from discussion at the recent PPSG meeting, it is not clear whether all parties are satisfied with the proposals. I regret this is not helpful. The view was expressed that the new 25,903 requirement should refer to the need for engines to be capable of being restarted, without excessive loss of altitude. Otherwise the AC/ACJ material can be seen to be rule-making.

Paragraph 15. There is an ICAO requirement (ANNEX 8, Chapter 7, 7.1.4)for a restart means and a declared maximum altitude has to be established for which this means is available. The new proposals will still conform with ICAO requirements.

5. 25.905 PROPELLER BLADE RELEASE

Paragraph 6. The proposed AC/ACJ is acceptable to the PPSG in principle.
Paragraph 15. There are no known ICAO requirements for Propeller Blade Release.

6. 25.934 TURBO-JET ENGINE THRUST REVERSER SYSTEM TESTS

Paragraph 6. The proposal to retain the current text of JAR 25.934 and Harmonise the FAR 33 requirements with those of JAR-E (is acceptable to PPSG).

Paragraph 15. There are no known ICAO requirements for Thrust reverser testing.

7. 25.943 NEGATIVE ACCELERATION

Paragraph 6. The proposed AC/ACJ is acceptable to the PPSG in principle.

Paragraph 15. There are no specific ICAO requirements for Negative acceleration, but there is a general requirement for powerplant systems to function 'within anticipated operating conditions'. The new proposals will still conform with ICAO requirements.

8. 25.1091 WATER INGESTION

Paragraph 6. The report recommends that the JAR 25.1091(d)(2) and its ACJ approach should be adopted. This is acceptable to the PPSG.

Paragraph 15. There are no specific ICAO requirements for Water ingestion, but there is a general requirement for powerplant systems to function 'within anticipated operating conditions'. The new proposals will still conform with ICAO requirements.

9. 25.1093 - FALLING AND BLOWING SNOW

Paragraph 6. The PPSG are committed to the introduction of the 'falling and blowing snow' requirement. They have also accepted that the requirement applies in principle to flight conditions as well as ground conditions. However, there are no known test methods for conducting flight tests in falling and blowing snow condition. The latest AC/ACJ proposal still mentions 'tested for snow ingestion' [in f.3)]; it is recommended that alternative compliance means are proposed.

Paragraph 15. There is no comparable ICAO standard.

10. 25.1141 - POWERPLANT CONTROLS

Paragraph 6. Either of the proposals given in the Report would be acceptable to the PPSG.

Paragraph 15. There is no comparable ICAO standard.

11. 25.1187 - DRAINAGE AND VENTILATION OF FIRE ZONES - RELATIONSHIP WITH 25.863.

No further points - comment fatigue has set in! But see my earlier comments below:

APPLICABILITY OF § 25.863 FLAMMABLE FLUID FIRE PROTECTION

1. The discussion about whether 25.863 also applies to the Powerplant Installation, has continued for a long time, without my ever, positively, knowing what was the original intent. This is a good opportunity to clarify the position.

2. Since joining the CAA, I have consistently assumed that 25.863 did NOT apply to the Powerplant installation for the following reasons:

- *This was the view of my predecessors.*
- *Although 25.1181 (in the Powerplant Installation Fire Protection section) specifically defines a number of requirements to be met for Designated Fire Zones (DFZ), including 25.867 and (for JAR) 25.869, there is NO inclusion of a reference to 25.863.*
- *Similarly, for areas behind firewalls (25,1182), there are a number of referenced requirements to be met, but NOT 25.863.*
- *An old copy of CAR 4b (Dec 53) shows the same approach for DFZ i.e. no reference to the equivalent of 25.863 (4b.385) . But for areas behind firewalls, there is a reference to 4b.385.*
- *25.863 includes some requirements, which duplicate those in the Powerplant Installation Fire Protection section e.g:*

FAR/JAR 25.863	*POWERPLANT FIRE PROTECTION*
(a) ...minimise probability of ignition of the fluids ...	*25.1183 ... safeguard against ignition of leaking flammable fluid.*
(b)(1) ... paths of fluid leakage ...	*25.1187 Drainage and ...*
(b)(4) Means available for controlling or extinguishing a fire, such as stopping flow of liquids ...	*25.1195 Fire extinguisher systems* *25.1189 Shut-off means*
(b)(5) components ... to withstand fire and heat.	*25,1183 each component ... must be fire resistant ...* *... fluid tanks ... must be fireproof ...etc.*

- *there is no requirement in '863' which is not covered by the powerplant fire protection requirements.*

This level of duplication tends to lead to a conclusion that there is a different applicability.

3. I recognise that the current FAA view is that 25.863 should be applied to the Powerplant Installation, but I consider that it would be useful to ascertain whether this was the original intention. Whether or not, this proves not to be the case, then I would strongly support a divorcing of the two sets of fire precaution requirements - 'Powerplant' and 'Rest of Aircraft'. There are considerable differences in the probability of fires occurring and the resulting effects on the aircraft, for the two areas, to warrant having separate sets of requirements. If it is considered that there is some requirement in 25.863, which should also be in the Powerplant Fire Precautions *section, then we should include it, but I foresee a number of advantages for both Subpart D and Subpart E specialists to have complete autonomy over their requirements.*

4. In answer to Kris's point in E-mail dated 20 Oct 99, I do not consider that the applicability of requirements needs to be based upon who tends to do the finding of compliance.

5. However, if the current FAA view holds, as an absolute minimum, 25.1181 and 1182 need to be revised to include references to the 25.863 requirement.

12. 25.1189 – FLAMMABLE FLUID SHUT-OFF

Paragraph 6. The proposed AC/ACJ is acceptable to the PPSG in principle.

13. APPENDIX I – ATTCS

Paragraph 6. The proposed AC/ACJ is acceptable to the PPSG in principle.

R W BONING

PPSG CHAIRMAN
5 NOV 99

Draft Advisory Circular

#5

23017

U.S. Department
of Transportation
Federal Aviation
Administration

Subject: FLAMMABLE FLUID FIRE PROTECTION **Date: XX-YY-02** **AC No 25.863-1**
Initiated by: ANM-110

TABLE OF CONTENTS

1. PURPOSE. This advisory circular (AC) provides information and guidance concerning a means, but not the only means, of compliance with §25.863 and §25.1187 of the Federal Aviation Regulations (FAR) pertaining to certification requirements for areas in transport category airplanes that are subject to flammable fluid leakage. Accordingly, this material is neither mandatory nor regulatory in nature and does not constitute a regulation. In lieu of following this method, the applicant may elect to establish an alternative method of compliance that is acceptable to the Federal Aviation Administration (FAA) for showing compliance with the requirements of the sections of the FAR listed below.

2. RELATED DOCUMENTS.

a. Related Federal Aviation Regulations (FAR).

Sections 25.729(f), 855(e), 859, 863, 901(b)(2) and (c), 954, 967, 1091(d)(1), 1121(b) and (d), 1163 (b), 1181, 1182, 1183, 1185(c), 1187, 1189, 1191, 1192, 1193, 1195, 1207, 1309, and 1435(c) of the FAR.

b. Technical Standard Orders (TSO).

TSO-C53a, Fuel and Engine Oil System Hose Assemblies.
Technical Standard Orders can be obtained from the Federal Aviation Administration (FAA), Aircraft Certification Service, Aircraft Engineering Division (AIR-120), 800 Independence Ave., SW, Washington, D.C. 20591.

c. Advisory Circulars (AC).

AC 25-8	Auxiliary Fuel System Installations.
AC 25-16	Electrical Fault and Fire Prevention and Protection.
AC 20-53A	Protection of Airplane Fuel Systems Against Fuel Vapor Ignition Due to Lightning.
AC 20-135	Powerplant Installation and Propulsion System Component Fire Protection Test Methods, Standards, and Criteria.
AC 25-901X	(Draft)Safety Assessment of Powerplant Installations
AC 25.981-1A	Guidelines for Substantiating Compliance with Fuel Tank Temperature Requirements.
AC 25-1309-1B	(Draft) System Design and Analysis
AC 43.13-1A	Acceptable Methods, Techniques, and Practices-Aircraft Inspection And Repair.

Advisory Circulars can be obtained from the U.S. Department of Transportation, M-443.2, Utilization and Storage Section, 400 7th Street SW, Washington, D.C. 20590.

d. Technical Publications.

(1) Latest version of Radio Technical Commission for Aeronautics (RTCA) Document DO-160/ED14, "Environmental Conditions and Test Procedures for Airborn Equipment." (This document can be obtained from the RTCA, One McPherson Square, Suite 500, 1425 K. Street Northwest, Washington, DC. 20005.)

(2) Handbook of Aviation Fuels Properties, Coordinating Research Council (CRC) Document 530 (This document can be obtained from the Society of Automotive Engineers, Inc., General Publications Department, 400 Commonwealth Drive, Warrendale, PA 15096.)

(3) Kuchta, Joseph M., Summary of Ignition Properties of Jet Fuels and Other Aircraft Combustible Fluids, Air Force Aero Propulsion Laboratory Technical Report AFAPL-TR-75-70, US. Bureau of Mines PMSRC, 1975. (This document can be obtained from the National Technical Information Service (NTIS), US. Department of Commerce, Springfield, VA 22151.)

(4) Parts, Leo, Assessment of the Flammability of Aircraft Hydraulic Fluids, Air Force Aero Propulsion Laboratory Technical Report AFAPL-TR-79-2055, July 1979. (This document can be obtained from the National Technical Information Service (NTIS), US. Department of Commerce, Springfield, VA 22151.)

(5) Kuchta, Joseph M., and Clodfelter, Robert G., Aircraft Mishap Fire Pattern Investigation, Air Force Aero Propulsion Laboratory Technical Report AFWAL-TR-85-2057, August 1985. (This document can be obtained from the National Technical Information Service (NTIS), US. Department of Commerce, Springfield, VA 22151.)

(6) Clodfelter, Robert G., Hot Surface Ignition and Aircraft Safety Criteria, Society of Automotive Engineers Paper 901950, October 1990. (This document can be obtained from the SAE Customer Service Department, Phone (877) 606-7323).

(7) Society of Automotive Engineers, Fire Resistant Phosphate Ester Hydraulic Fluid for Aircraft, Aerospace Standard AS1241C.

3. DEFINITIONS.

> NOTE: For definitions below pertaining to flammability, ignition, and fire characteristics of aircraft fluids, refer to Appendix A for more detailed information.

a. The Airplane Operating and Environmental Conditions. Includes those:
   - throughout the full normal operating envelope of the airplane, as defined by the Airplane Flight Manual, together with any modification to that envelope associated with abnormal or emergency procedures and any anticipated crew action; and
   - under the anticipated external and internal airplane environmental conditions, as well as any additional conditions where equipment and systems are assumed to "perform as intended" when complying with the requirements of § 25.1309(b) or other applicable regulations.

b. Autogenous Ignition Temperature (AIT). The minimum temperature at which an optimized flammable vapor and air mixture will spontaneously ignite under particular laboratory test conditions. Also sometime refereed to as minimum auto-ignition temperature.

c. Baffle Rib. A vapor barrier or dam that segments the leading or trailing edge of the wing such that leaking flammable fluids (liquid or vapor) are controlled to reduce the likelihood of ignition. Baffle ribs provide a means to control drainage and ventilation within zones and divert fluids away from the fuselage thereby limiting propagation of fire.

d. Designated Fire Zone (DFZ). Areas that have been designated as fire zones are listed in § 25.1181 as the engine power section, the engine accessory section, the APU compartment, any fuel burning heater (or combustion equipment described in § 25.859), the compressor and accessory sections of turbine engines, and the combustor, turbine and tailpipe sections of turbine engine installations that contain lines or components carrying flammable fluids.

e. Fire Zone. A flammable fluid leakage zone that contains a nominal ignition source.

> Note
>
> This is not a Designated Fire Zone per 25.1181 as defined above. It is a zone where means to protect the airplane from the hazardous effects of fire may be required, but these means may differ from the fire protection means for designated fire zones per FAR/JAR- 25, Subpart E.

f. Flammability Limit. The highest and lowest concentration of fuel in air by percent volume that will sustain combustion is the flammability limit. A fuel to air mixture below the lower limit is too lean to burn while a mixture above the upper limit is too rich to burn. The flammability limit varies with altitude and temperature and is typically presented on a temperature vs. altitude plot

g. Flammable Fluid. Flammable, with respect to a fluid (liquid or vapor), means susceptible to igniting or to exploding. This includes any fluid which can burn such as fuels, hydraulic fluid (including phosphate ester based fluids such as "Skydrol"), petroleum and synthetic oils, and some ice protection fluids.

h. Flammable Fluid Leakage Zone. Any area where flammable liquids or vapors are not intended to be present, but where they might exist due to leakage from flammable fluid carrying components (e.g. leakage from tanks, lines, etc.).
i. Flash Point. The minimum temperature at which a flammable liquid will produce a flammable vapor/air mixture at sea level ambient pressure per the applicable fluid specifications and test procedures.
j. Flammable Fluid Ignition Source. A heat source, which is anticipated to occur under the Airplane Operating and Environmental Conditions, which has sufficient temperature and/or energy to initiate combustion of the flammable fluid in question.
k. Maximum Allowable Surface Temperatures. A temperature 50°F below the autogenous ignition temperature, which can be conservatively considered not to be an ignition source without further substantiation, per general industry/FAA practice.
l. Nominal Ignition Source. A flammable fluid ignition source, which is not associated with a failure condition.
m. Potential Ignition Source. A flammable fluid ignition source, which is associated with a failure condition.
n. Telltale Drain. A drain outlet system that allows identification of a leaking accessory in a compartment that contains many accessories, or a manually activated device, which is used to determine whether fluid has flowed through a drain line or shroud.
o. Vapor Barrier. A barrier installed to confine liquid or vapor within a fire zone or flammable fluid leakage zone.

4. BACKGROUND.

a. General Flammable Fluid Fire Protection. §25.863 addresses flammable fluid fire protection for areas of the airplane subject to leakage of any flammable fluid. §25.863 requires minimization of both the probability of ignition of leaked flammable fluids and the hazard if ignition occurs. In this regard, the purpose of this AC is to provide compliance guidance for §25.863 and to minimize past inconsistencies in the following areas:
   - Applicability of §25.863
   - Definition of ignition probability and hazard minimization and their relationship to each other and to the more general requirements of §25.901(c)/25.1309, particularly with regard to different types of fluids and leakage and ignition scenarios.
   - Role of drainage and ventilation in showing compliance.

b. Designated Fire Zone /Drainage and Ventilation. A common cause of airplane fires has been the ignition of leaked flammable fluids. One primary means of mitigating such fires, which is required by §25.1187 for designated fire zones, is to prevent the accumulation of flammable liquids by safely draining the liquids away from the airplane, both in flight and on the ground, and to prevent the accumulation of flammable vapors as well as the formation of a flammable mixture by providing adequate ventilation. In this regard, the purpose of this AC is to provide guidance on what factors should be considered in the design of flammable fluid drainage systems and ventilation systems, and to describe a means of showing compliance with the sections of the FAR that address these systems.

5. FLAMMABLE FLUID FIRE PROTECTION COMPLIANCE (§ 25.863).

5.a. Applicability and Zone Classification.

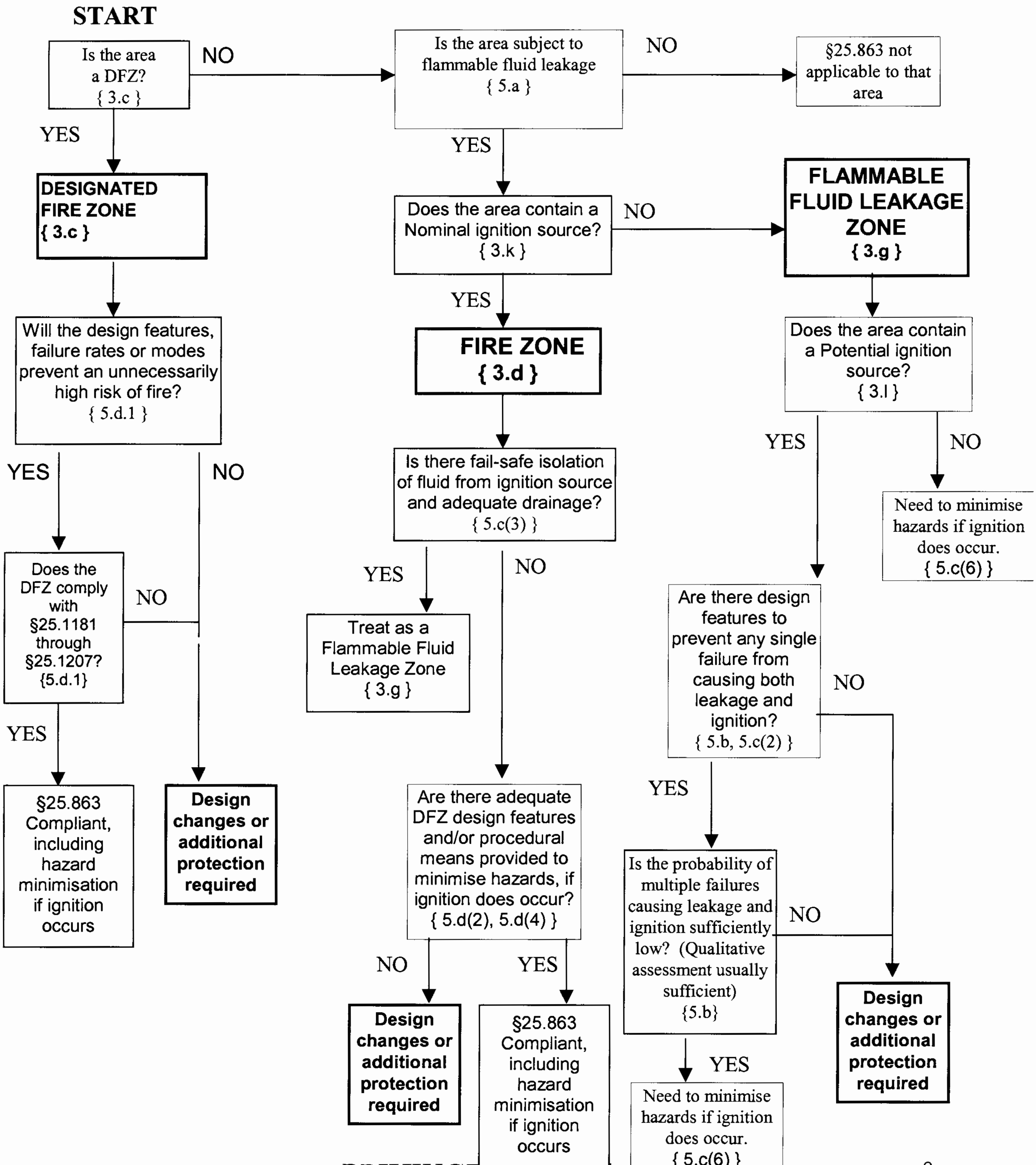
§25.863 is applicable to areas of the airplane that could be exposed to flammable fluid leakage from airplane systems. The origin of the leakage could be a different area of the airplane than the area exposed. §25.863 is not applicable to the following areas or situations, which are addressed by other regulations:

- Areas normally containing flammable fluid, such as the interior of flammable fluid system tanks, components, and plumbing.
- Flammable fluids not associated with airplane systems, such as those contained in cargo, baggage, personal possessions, and cabin stores.
- Flammable fluid leakage caused by a crash or wheels up landing, engine or APU rotor non-containment or case burst or case burn through, or catastrophic failure of primary structure.

An analysis of leak sources and leak paths should be conducted per §25.863(b)(1) and (d) to determine which areas should be classified as flammable fluid leakage zones. If analysis is insufficient to predict whether an area is subject to flammable fluid exposure from a source outside the zone, either tests can be conducted per 6 b. or it can be conservatively assumed that the area is exposed to the leakage. When analyzing failures that cause leakage, it is appropriate to consider the anticipated failure sequence. For example, leakage due to cracks or sealant degradation in integral fuel tanks would be expected to progress through low rate seeping and dripping type leaks and may be detectable prior to reaching higher leakage rates. On the other hand, leaks involving high pressure fluid lines and components could progress fairly rapidly to a spray type leak, which can be more critical than a higher rate streaming type leak, especially for high flash point fluids.

Section 5.b. below discusses hazard minimization concepts, Section 5 c. below discusses various tools available for flammable fluid fire protection, and Section 5 d. below discusses applicability of the hazard minimizations concepts and tools to various airplane areas, flammable fluid types, and scenarios. Figure 5.a-1 presents a flow chart for determining compliance of a particular area with 25.863. In this Figure, references in brackets, e.g. {3.c}, refer to the relevant Section of this AC.

FIGURE 5.a-1 FLOW CHART FOR §25.863 COMPLIANCE.



5.b. Hazard Minimization and Relationship with 25.901(c)/1309

§25.863(a) requires that:

> In each area where flammable fluids or vapors might escape by leakage of a fluid system, there must be means to minimize the probability of ignition of the fluids and vapors, and the resultant hazards if ignition does occur.

There has previously been little available guidance or interpretation of the meaning of minimizing the probability of ignition or minimizing the resultant hazards if ignition does occur. Further, there has been little guidance or interpretation regarding the relationship between these two objectives. That is, as the probability of ignition goes down, does what must be done to "minimize" the resultant hazards if ignition does occur?

There have been accepted means of compliance for various generic airplane zones and types of flammable fluids, which are discussed further in the individual sections below.

Hazard minimization can be considered to be that which is technically feasible and economically practical. As a minimum, since the hazards associated with flammable fluids are not excepted from §25.901 or §25.1309, acceptable flammable fluid fire protection must comply with the following §25.901/1309 related requirements:

Under §25.901(c):

- No single or anticipated combination of failures or malfunctions shall jeopardize the safe operation of the airplane.

Under §25.1309:

- Catastrophic effects resulting from ignition of flammable fluid (liquid or vapor) leakage shall be extremely improbable and not be caused by a single failure.
- Hazardous effects resulting from ignition of flammable fluid (liquid or vapor) leakage shall be extremely remote.
- Major effects resulting from ignition of flammable fluid (liquid or vapor) leakage shall be remote.
- Information concerning unsafe system operating conditions must be provided to the crew to enable them to take appropriate corrective action

Service experience has shown that the single most important aspect of these requirements is the prevention of catastrophic effects due to a single failure. This means:

- A single failure, such as a wire chafing on a tube, may not cause both a leak and an ignition source.
- If the single failure is a leak, an ignition source may not be present under normal or anticipated latent failure conditions.

Compliance methodology should be generally consistent with AC 25.1309-1, however it is noted that there may be more reliance on fail safe design, qualitative assessment and engineering judgment than quantitative probabilities. This is due to practical limits on determining and justifying quantitative probabilities for some flammable fluid leakage and ignition scenarios. Further "minimization" beyond that required to comply with §25.901/1309 is often not "technologically feasible or economically practicable". However in those cases where it is, compliance with §25.863 requires that further "minimization" be provided. This could apply to either further minimization of the probability of ignition or further minimization of the resulting hazards if ignition does occur.

5.c. General Protection Considerations.

(1) Ventilation and Drainage.

Unlike the requirements for designated fire zones, drainage and ventilation are not specifically required for compliance with §25.863. They can, however, be useful means to address the requirements for both the ignition probability minimization and hazard minimization if ignition occurs. The degree of effectiveness will vary with the type of fluid leakage characteristics and ignition scenario(s). In addition, drainage is useful for detection of slow leaks so as to avoid prolonged exposure or progress to a more severe leak. Several examples of effectiveness of drainage and ventilation for various situations are shown in Table 5.c-1.

In cases where drainage or ventilation is determined to be effective, the substantiation guidelines per Section 6 should be considered. Strict compliance with the guidelines of Section 6 may not be necessary, depending on the specific situation.

Condition	Drainage Effectiveness	Ventilation Effectiveness
Slow leak and/or limited leakage quantity of a fluid with a relatively low flashpoint in relationship to compartment and fluid temperature.	Drainage is effective in limiting size and duration of pools (and fires) and in leak detection and repair, although leak detection may not be effective for very small leaks.	Ventilation is effective in prevention of explosive ignition and should minimise probability of flammable vapor contact with an ignition source.
More rapid leak and/or higher leakage quantity of a fluid with a relatively low flashpoint in relationship to compartment and fluid temperature.	Drainage effectiveness reduces as leak rate increase relative to flow capability of drains. Drainage is effective in leak detection.	Ventilation effectiveness becomes less as vapor formation rate increases relative to ventilation rate.
Non-spray type leak of a fluid with a relatively high flashpoint in relationship to compartment and fluid temperature.	Not generally susceptible to ignition of pools, so that drainage may be less beneficial in prevention, but still limits magnitude if ignition occurs. Note: Assumes pool not heated by a fire. Drainage is effective in leak detection.	Not generally susceptible to flammable vapor formation so that ventilation may not be beneficial.
Spray type leak	Limited effectiveness in preventing fire if the spray contacts an ignition source, but still limits magnitude if ignition occurs. Drainage is effective in leak detection.	Limited effectiveness if the spray contacts an ignition source.

Table 5.c-1
Drainage and Ventilation Effectiveness

Note

Relatively high flashpoint in relationship to compartment or fluid temperature means a significant difference on the order of 150° F (83° C). Based on this criterion, all fuels, alcohols, and petroleum based oils or hydraulic fluids will be generally considered relatively low flashpoint in at least portions of the operating envelope. Synthetic oils and hydraulic fluids may be considered relatively high flashpoint, depending on the assessment of flashpoint in relationship to compartment or fluid temperature. Refer to Appendix A for additional fluid data.

(2) Separation Of Leakage from Ignition Sources (Nominal and Potential).

Separation of leakage and ignition sources is a fundamental tool in minimizing the probability for ignition, particularly with respect to preventing a single failure from causing both leakage and ignition.
Analysis should substantiate separation of leakage sources and ignition sources. As stated in AC 43.13-1A, an arc fault between an electrical wire and a metallic flammable fluid line may puncture the line and result in a serious fire. When wiring is run parallel to or crossing flammable fluid lines, maintain as much separation as possible. Wherever possible, locate wires above or level with the fluid lines and not in the same vertical plane. This helps reduce the likelihood that flammable fluid leakage will impinge upon wiring and that any hot materials liberated due to wire arcing is less likely to fall onto and melt into flammable fluid lines. Wherever possible maintain a minimum separation of six inches. In tight spaces (such as the engine strut) where separation is reduced, install clamps or insulating material to assure fluid line contact and arcing are not possible. Based on in-service experience, the minimum clearance between wiring and flammable fluid carrying lines should not be less than one inch during worst case failure conditions, taking into consideration, relative motion of aircraft structure due to wing deflection or engine movement and manufacturing tolerances. The failure conditions to be considered include such things as: clamp, bracket, or other attachment failures for the plumbing and wiring and wire failure that would cause the wire end to protrude from its normal routing. Separation also applies to other potential ignition sources, such as hot gas components, energy storage devices and mechanical components, considering their associated failure modes.

Note
Service experience has shown that wiring, especially relatively high power wiring, in contact with or in proximity to flammable fluid lines can cause both the leak and ignition source and is a prevalent cause of actual flammable fluid ignition events.

(3) Isolation of Leakage from Ignition Sources (Nominal and Potential)

Isolation of flammable fluid leakage and ignition sources consists of physical barriers which will prevent contact between leakage, including vapors, and all ignition sources. Of particular interest is isolating high pressure leaks from ignition sources. Typical means of isolation include shrouds around flammable fluid carrying plumbing and components, double walled fuel tanks, and transparent secondary coatings on integral tanks, which prevent leakage from sealant leaks or structural cracks, but permit detection of these leaks. The volume between the fluid boundary and the isolation means should not contain any ignition sources, and should be ventilated and drained to either outside the airplane or another area where the presence of flammable fluid leakage will be detected before the isolation means is compromised. Isolation is normally accepted as a means of compliance with §25.863, provided that following is shown.

- The isolation means is capable of flowing expected leak rates without leaking or failing itself.
- The isolation means is expected to remain intact and effective between normal inspections and/or overhauls.
- Drainage of fluid from the isolated volume exit is shown to comply with §25.863, and is reasonably detectable during ground pre-flight or routine inspection.
- Where a fluid leak is expected to result in ignition, it is shown that a single failure, including structural failure, will not cause both a leak and failure of the isolation means.

Partial isolation can also be effective in some situations to minimize both the probability of ignition or the resultant hazard if ignition occurs. One example is the use of baffle ribs in wing leading edge to allow leakage drainage without the leakage migrating to other areas that could increase both the probability of ignition and the size and hazard of the fire if ignition occurs. Another example is the use of wiring conduits or other forms of local shielding to minimize leakage contact with potential ignition sources. This is particularly applicable to situations involving high flash point fluids where the main ignition hazard involves a pressurized spray.

(4) Component Qualification.

Components located in flammable fluid leakage zones should be qualified to show that they are not nominal ignition sources. Electrical components may be qualified for use within flammable fluid leakage zones by showing the unit meets the appropriate criteria such as the explosion proof requirements as defined in AC 25-16, e.g. Section 9 of RTCA Document DO-160/ED14 or BS 3G-100. Other components must be shown to be free of potential arcing or friction ignition sources and have maximum surface temperatures with margin below the autogenous ignition temperature of the flammable fluid that could exist within the zone.
Requirements for components to be qualified as not being ignition sources in failure conditions will vary considerably depending on the failure modes and probability, the leakage and ignition scenario involved, and the other means used to minimize the probability of ignition.

Note Ignition Potential of Equipment
Determination of ignition potential for equipment may involve considerations additional to qualifications per RTCA DO-160/EB14, Section 9, for the following reasons: Category A explosion-proofness may not be applicable for all equipment, and it does not address ignition potential of faults in wiring connecting to the equipment. Category E or H equipment testing showing absence of ignition potential in normal operation is necessary in flammable fluid leakage areas, however, it is also necessary to consider

ignition potential and probability under fault conditions.

Note

Maximum Acceptable Surface Temperature

While it has been generally accepted FAA, JAA and industry practice to use a maximum acceptable surface temperatures of 50° F below the applicable fluid AIT (i.e., approximately 400° F/200° C for jet fuels), somewhat higher temperatures have been accepted in certain cases if substantiated. For example, manufacturers have substantiated that the conditions (ambient pressure, dwell time, fuel type, etc.) within certain flammable fluid leakage zones are such that a higher value may be used. For example, maximum allowable pneumatic bleed duct surface temperatures of 450°F., with a transient excursion up to 500°F. for a maximum of two minutes has been approved. The excursion above 450°F. occurs only during failure conditions such as an engine pneumatic high stage bleed valve failure or duct rupture. Approval of these elevated temperatures has been based on compensating design features such as cockpit indication of over-temperature and associated procedures to shutoff the overheated system, insulated ducts, zone ventilation airflow which produces a lean fuel to air mixture, and an automatic over-temperature shutoff of the pneumatic system so that the temperature cannot exceed the accepted 450°F. value for more than two minutes

(5) Cooling Air Ducts.

The cooling air supply and/or discharge for any electrical, electronic or mechanical equipment should be conveyed within the aircraft and discharged from the aircraft so as not to create a hazard following failure of the equipment resulting in potential ignition sources such as hot gases, flames, or friction sparks. Where required the cooling duct should be fireproof and/or insulated.

(6) Condition Monitoring, Detection and Accommodation

Monitoring for, detecting and accommodating conditions which could contribute to a flammable fluid ignition hazard is a common and effective aid in minimizing that hazard. Condition Monitoring and Accommodations can take many diverse forms including:

- Looking for and detecting overboard drainage of flammable fluids during the pre-flight "walk around" inspections. When combined with suitable dispatch restrictions when such leakage is noted, this type of condition monitoring can help minimize the exposure times associated with detectable leakage;
- "Overcurrent" and/or "Overheat" monitoring within flammable fluid tanks, pumps and/or other flammable fluid carrying components. When an "overcurrent" or "overheat" condition is sensed, accommodations are triggered either automatically or through crew indications and procedures (e.g. thermal switches that automatically shut off overheating

flammable fluid pumps, fluid tank temperature indications which combined with operating limitations and crew procedures trigger isolation of overheating fluid systems, etc.). This type of condition monitoring can help minimize the hazards associated with exceedingly hot flammable fluids and/or fluid system components (i.e. ignition of flammable fluids within the fluid system, leakage of hot flammable fluids, etc.)

- "Fire" and/or "Overheat" monitoring within a flammable fluid leakage zone (most commonly used within designated fire zones). When a "fire" or "overheat" condition is sensed, accommodations are triggered either automatically or through crew indications and procedures (e.g. cockpit "Fire Warning" indication combined with crew procedures to minimize the fire hazard (e.g. shutting off the flow of flammable fluids and/or ventilation air into the zone, releasing fire extinguishing agent into the zone, etc.; "Overheat" sensors used to detect hot air from an ECS duct burst and automatically shut off ECS airflow; etc.);
- Detection and accommodation of other conditions known to cause flammable fluid leakage, ignition sources, reduced ventilation or drainage, loss of some flammable fluid fire protection means, or otherwise contribute to a flammable fluid ignition hazard (e.g. circuit breakers to stop arcing due to shorted power wires, inspections/functional tests to detect clogged drainage provision, selection of "closed" as the "fail-safe" state for cooling air valves, means to detect failures within the fire detection means, periodic maintenance to assure fire extinguishing capability, etc.).

<u>(7) Protection If Ignition Occurs.</u>

In additional to minimizing the probability of ignition, §25.863(a) requires that the resultant hazard be minimized if ignition does occur. As discussed in Section 5 b., this requirement is additional to the safety requirements of §25.901(c)/1309, but minimization is associated with constraints on technical feasibility and economic practicality.

Designated fire zones require the protection means outlined in §25.1181 through §25.1207, which provide the required hazard minimization if ignition occurs (see Section 5 d.(1) below). Nacelle areas behind firewalls and pod attaching structures containing flammable fluid lines require the protection means outlined in §25.1182, which provide the required hazard minimization if ignition occurs (see Section 5 d.(3) below). Other fire zones (containing a nominal ignition source), wheel wells , and occupied areas are discussed further in Sections 5.d.(2), (4) and (5).

For flammable fluid leakage zones, the following provisions have been generally accepted as minimizing the hazard if ignition occurs.

- Provide ventilation in areas to minimize the amount of flammable vapors resident in the zone.
- Provide ventilation to minimize the probability of the ignition being an explosion.

- Provide a means to shut off ventilation airflow, following flightdeck indication of a fire.
- Provide the maximum practical amount and effectiveness of drainage so as to minimize leakage volume available and provide detection to minimize multiple flight leakage exposure. Note that this may vary by area and type and quantity of fluid. For example, it is usually not practical to drain pressurized areas in flight. This could be acceptable for relatively low quantities of relatively high flashpoint fluids, but other means would be necessary for lower flashpoint fluids.
- In the case where some residual undrained fluid is present, or in the case where drainage is not practical for all phases of flight, consider the effects of igniting the residual undrained fluid. Special attention should be paid to critical structure and systems, other flammable fluid systems and the spread of fire. It is necessary to consider independently caused fires as an ignition source with respect to creating or igniting the leakage so that the ignition would increase the hazard by adding to the size or intensity of the fire or causing it to spread to other areas.
- If the above means do not adequately minimize the hazard, consider whether there are other or additional practical means, such as improved drainage, isolation, etc., to further minimize the hazard, or whether protection means, such as that associated with designated fire zones are necessary.

5.d. §25.863 Compliance Considerations for Different Airplane Areas.

(1) Designated Fire Zones.

§25.863 is applicable to designated fire zones per §25.1181, however, in most cases compliance with the fire protection requirements (§25.1181 to §25.1207) of 14 CFR 25, Subpart E, provides inherent compliance with §25.863. The emphasis here, of course, is minimizing and preventing the hazardous effects of fire, since it is inherent within the philosophy of designated fire zones, that ignition sources are anticipated - nominal ignition sources.

However if design features result in an unusually high probability of fire, additional effort may be required to show compliance with §25.863. If for example the unusual failure rates or modes of a component resulting in a flammable fluid leak or ignition source were high enough to significantly increase the probability of fire in the designated fire zone, then additional means would be necessary under §25.863 to minimize that probability. For example, §25.863 wouldn't allow an electrical power feeder cable to be attached to a fuel feed pipe, even within a designated fire zone.

(2) Fire Zones.

Other fire zones are those that are subject to flammable fluid leakage and contain a nominal ignition source. Wheel wells, discussed further in Section 5 d.(4), may be one example, but there may be others for specific airplane designs. As previously discussed in Section 6 c.(3), one acceptable compliance means is isolation so that the zone is no longer subject to leakage and, therefore is no longer classified as a fire zone. In the event that this is not practical, the various means of protection prescribed for designated fire zones should be considered and applied as appropriate.

(3) <u>Areas Adjacent to Designated Fire Zones.</u>

These areas can include pylon, strut, and nacelle areas behind the firewall, fan cowls that are not designated fire zones, and areas adjacent to many different types of APU compartments. The nacelle areas may include wheel wells in some cases.
The firewall boundary may constitute an ignition source in the case of a fire in the designated fire zone. There have been several accepted means of addressing §25.863 with respect to this situation:

- Use insulation, compartmentalization or other means so that firewall surfaces of these areas do not become hot enough to be an ignition source for the fluids involved, or:
- Substantiate that the fire in the Designated Fire Zone will not itself cause flammable fluid leakage in the adjacent area, and that the combined probability of the fire and an independent failure causing flammable fluid leakage meets both the applicable fail-safe requirements of §25.901/1309 and the "minimization" criteria discussed above. Include the anticipated degree of latent leakage and resulting ignition susceptibility and effects.

<u>Note</u>
Substantiation of the absence of latent leakage sufficient to cause a hazard for this option could be difficult, depending on airplane size, configuration, and leakage flow paths.

In addition, fire protection requirements for some of these areas (nacelle areas behind firewalls and engine pod attaching struts)are specified by §25.1182. These requirements can be considered in showing compliance with §25.863, but they do not inherently show compliance by themselves since they do not address minimizing probability of ignition.

(4) <u>Wheel Wells.</u>
Wheel wells generally contain flammable hydraulic fluid, may be subject to fuel leakage, can contain nominal ignition sources (e.g. hot surface ignition source resulting from brake usage or dragging brakes) and require specific single failure consideration with respect to tire burst, tire tread debris and flailing.
Due to the wide variety of designs, it is not practical to provide acceptable means of compliance for each specific design. However, the following is a list of design features that have been used in various combinations for hazard minimization and compliance:

- Design considerations required to show compliance to §25.729(f) (considerations for wheel and tire failures and brakes overheat). .
- Installation of fluid systems, especially fuel, so that leakage does not enter the wheel well.
- Inherent drainage and ventilation provided by not using completely sealed wheel well doors.

- Volumetric fuses on brake lines or other brake design features to limit amount of hydraulic fluid that can feed a brake fire.
- Means, such as shrouds, to minimize the probability that leaking flammable liquids would contact a hot brake surface.
- Installation of wheel well overheat/fire detector combined with procedures to extend the gear or otherwise cool/extinguish the fire if an overheat/fire is detected.
- Installation of brake temperature indication combined with procedures to not retract the gear (or to extend the gear if retracted) until the brake temperatures are within limits.
- Mechanical shielding or sleeves on electrical wire bundles.

(5) <u>Occupied / Pressurised Areas.</u>

Passenger and crew compartments and areas connected to them, such as pressurized avionics, baggage or cargo areas, should be considered to contain nominal ignition sources, notably carry-on articles and galley service equipment. Installation of flammable fluid tanks, lines and other flammable fluid carrying components in these areas should be avoided.
Further, §25.967(e) requires that fuel tanks must be isolated from personnel compartments by the kinds of measures outlined in section 5.c.(3). Best current practice for compliance with §25.863 is that all flammable fluid carrying lines and components, within the personnel compartments are also isolated by vapor proof and liquid proof enclosures (e.g. shrouding). Where tanks (in their isolation enclosures) are located in baggage or cargo compartments, §25.855(e) requires evidence to show that there is no risk of damaging the tank or its equipment, from the movement of cargo, to create a fire hazard.

While not best practice, unshrouded installations within these areas have been found acceptable for higher flash point fluids, such as MIL-H-83282, MIL-H-87257 or phosphate esters, provided they have flashpoint and auto-ignition temperatures much higher than compartment and component temperatures and provisions are present to keep spray type leakage from contacting any ignition source (nominal or potential). These provisions can include installation routing and shielding of spray paths by either adjacent structure or dedicated shield. Drainage provisions should be used to minimize puddling and maximize detectability of leaks, although it may be acceptable for drainage to not occur when the airplane is pressurized depending upon the situation, such as potential leakage rates and quantities.

It should be substantiated that air inlets for these areas, including those used or present during non-pressurized flight, will not ingest flammable fluid leakage from another part of the airplane.

(6) <u>Areas Containing Electrical and Electronic Equipment.</u>

<u>Note</u>
The considerations below apply to all electrical or electronic equipment subject to flammable fluid leakage, however the complexity and practicality of failure analysis is

magnified in areas with large amounts of electronic or electrical equipment simply due to the number of components, wire bundles, failure conditions, etc., involved.

For airplanes containing dedicated electronic and electrical equipment bays that are isolated from exposure to flammable fluid leakage. Substantiation that such areas are not exposed to flammable fluid leakage from other parts of the airplane, such as through cooling or pressurization airflow paths is all that's required to demonstrate that 25.863 does not apply.

It may be unavoidable that some areas of the airplane (e.g. tail cones and nose compartments) will contain both significant amounts of electrical and electronic equipment, and potential flammable fluid leakage sources. In these cases compliance with 25.863 must be demonstrated.

Zonal analysis and physical minimization should show that all flammable fluid components are protected against single failures causing both a leak and an ignition source, as previously discussed. The following additional provisions have been found acceptable:

For fuel or lower flashpoint hydraulic fluids, such as MIL-H-5606:
- Isolation provisions discussed in Section 5.c.(3), or
- For one piece lines (including lines with permanent fittings of integrity equivalent to the line) with a large design margin, substantiation that the electrical/electronic equipment will not be a nominal ignition source, per Section 5.c.(4), combined with compartment drainage and ventilation. (Using accepted design practices, the leakage probability is low enough that multiple failure requirements are typically met without specific additional substantiation.)
- For higher flashpoint hydraulic fluids, such as MIL-L-23282, MIL-L 87257 or phosphate esters: Substantiation that there is a large margin between the temperature of the electrical/electronic equipment in normal operation and that required for ignition.
- Minimize the probability that flammable fluids will spray or leak directly into/onto electrical/electronic equipment by means of location or spray/leakage barriers (using accepted design practices, the combination of low leakage probability for critical spray type leaks and low probability of ignition is low enough that multiple failure requirements are typically met without specific additional substantiation.)
- Drainage provisions should be used to minimize puddling and maximize detectability of leaks.

When it is necessary to prevent exposure of these areas to flammable fluid leakage from adjacent areas, ventilation that provides a positive pressure differential between the compartment and the adjacent area has been found to be acceptable.

(7) Areas containing Hydraulic System Components.

Areas containing Hydraulic System Components are generally susceptible to hydraulic fluid leakage, and can contain nominal ignition sources (e.g. hot surface ignition source).

Due to the number of substantially different type designs, providing acceptable means of compliance for each type is not practical. Nevertheless, the following is a list of design features that have been used in various combinations to minimize the probability of ignition and any resulting hazards.

- Design precautions taken to limit the hydraulic fluid quantity susceptible to be spilled.
- Permanent type couplings (swaged) used wherever possible.
- Flammable fluid carrying components located so as to minimize the potential for flammable fluid leakage to contact nominal or potential ignition sources.
- Dedicated design features provided to keep flammable fluid leakage or spray type leakage away from ignition sources (e.g. dedicated shield or spray covers).
- Adequate drainage paths provided to minimise puddling and maximize detectability of leaks.
- Adequate ventilation provided to minimise the hazards from flammable vapors (temperature reduction and purging).
- Temperature indications installed where abnormally high temperatures would increase the flammable fluid fire hazard (e.g. hydraulic fluid tanks, high power consumption electrical equipment, other potential ignition sources). Where practicable, the potential sources of overheating should be provided with an automatic cut off device (e.g. hydraulic pump overheat/over-current cut-off).
- Low level indication installed on hydraulic tanks leading to application of appropriate automatic/manual procedures.
- Safe discharge of electrostatic charges ensured by using appropriately bonded components including earthed, screened conductor wires.

6. Drainage and Ventilation Compliance (§25.1187).

6 a. Analysis.

(1) Zone Classification.

The drainage and ventilation requirements of §25.1187 apply to designated fire zones per 25.1181, to nacelle areas immediately behind the firewall per 25.1182, and to each portion of any engine pod attaching structure containing flammable fluid lines per 25.1182, and to engine cowlings per 25.1193. FAA/JAA interpretive policy excepts fan cowl zones from being classified as designated fire zones provided that they do not contain an accessory gearbox or other nominal ignition sources. If they are subject to flammable fluid leakage, they are classified as flammable fluid leakage zones.

(2) Leak Source and Drainage Analysis

The purpose of this analysis is to:

- Establish where leaks could occur and introduce measures to minimize leak rates where possible;

- Determine the anticipated maximum leakage rates for each leakage source,
- Confirm that adequate drainage is provided in the necessary locations,
- Identify where the drained fluid goes and show that no additional fire hazard will occur.

(i) Analysis Vs. Test. In some cases, it can be shown that leakage from unintended places and impingement on other parts of the airplane is clearly not possible. In these cases it may be permitted to show compliance by analysis. The analysis must show that the drainage system will perform under all intended flight conditions, and it must be substantiated that unfavorable pressure gradients do not exist under normal flight conditions so that the drainage system will function as intended. If there is any doubt about the analysis validity, then tests per 6.b. must be conducted.

(ii) Safety Implications. An analysis of the design should be conducted per the requirements and guidance of 25.901(c) to evaluate the safety implications of the potential leak sources for each fire zone. Special attention should be paid to failures which can result in large uncontrolled leaks that will exceed the drainage system design flow rate. Examples of large uncontrolled leaks that have occurred in the past include: engine fuel supply line coupling failures due to over tightening or mis-assembly of the coupling without the packing (o-ring), unsecured fuel filter, high pressure fuel line failure due to fatigue cracking and secondary fuel/vapor barrier failure due to cracking or misapplication.

(iii) Typical Drainage Rates. Typically, drainage systems should provide adequate capacity to handle fluid flow rates that could occur due to failure of a single seal, or cracking of high pressure lines. Drainage rates may also need to accommodate drainage of fluid trapped downstream of firewall shutoffs in a timely manner as needed to meet the requirements of 25.1189(e). It is not typically expected that drainage systems be capable of accommodating large leaks since they will be mitigated in other ways per 25.901(c). For example, many current airplanes were certificated based on demonstration of the drainage system flow capacity of one gallon per minute. This rate was established by analysis of the maximum leak possible when one o-ring seal was omitted from a fuel line coupling. Conversely, drainage rates traditionally do not accommodate the very large leakage rate that would result from the total separation of a main fuel feed line or hose. This is because the foreseeable failure modes of main fuel lines and hoses are traditionally limited to progressive failures whereby the resulting leakage can be detected and safely accommodated before complete separation occurs. In any case, the maximum anticipated leakage should be shown to comply with 25.901(c). The applicant should establish the proper drainage rate based on analysis of potential leaks sources within the zone.

(iv) Prevention of Excessive Leak Rates. Means to assure that leakage rates will remain within available drainage capacity can include, but are not limited to:

- installation of telltale drains that will provide maintenance awareness of small leaks;
- fail safe features on connections (such as shrouds around couplings, double attachment of fuel filters, and reduced flow areas around seal retention plates within couplings to restrict flow if seal failure occurs);

- isolation of high pressure leak source drains from low pressure leak source drains to preclude back flow into low pressure systems;
- location of drain lines away from heat sources that are of sufficient temperature to cause clogging due to residual carbon build-up (coking);
- installation of graduated/increased area drain screens over drain inlets to preclude clogging by debris, and drain line design to prevent ice clogging; and
- establishing damage tolerant safe lives for fuel lines, hoses and other components whose failure could create excessive leak rates.

One example of a drain screen that has been used for this purpose is a "finger screen" that extends vertically from the drain inlet and allows passage of fluid if debris collects around the base of the screen.

(v) Production and Maintenance Considerations. Airplane drain problems have occurred due to manufacturing discrepancies that resulted in failure of the drainage or sealing systems to perform their intended function. The drainage system analysis should also establish that type design manufacturing and inspection processes and procedures are in place to assure that necessary sealing provisions perform their intended function. Similarly, instructions for continued airworthiness per §25.1529 should insure that this capability is retained in service.

(vi) Drain Location and Drained Fluid Path. After the leak source analysis has been performed, the consequences of a maximum foreseeable leak should be evaluated to assure that a hazardous condition is not created. Sealing of compartments should be adequate to allow build-up of fluids without migration of fluid into areas where ignition could occur. The location of flammable fluid overboard drain outlets is critical in providing a design, which minimizes ignition of leaked fluids following drainage. The following guidelines can be useful in locating flammable fluid drain outlets:

(A) Overboard drain outlets should be arranged such that flammable fluids do not collect on the airplane when the airplane is stationary on the ground.

(B) Drain outlets should be located downstream of areas where drained fluid may reenter the airplane in any operating condition where it could cause an additional fire hazard.

(C) Outlets should be designed and/or located to meet the lightning requirements of §25.581 and § 25.954.

(D) Outlet location and line routing should be evaluated to assure there are no restrictions because of water traps that result in the accumulation of water or ice.

(E) Fire hazards created by flammable fluid exiting a drain and impinging or running along the outside of the airplane have been prevented by extending the drain mast beyond the boundary layer. Installation of a vortex generator on the drain mast upstream of the outlet may facilitate dispersion of the fluid and eliminate hazardous impingement on the airframe.

(3) Ventilation Analysis.

Fire zones must be ventilated to prevent the accumulation of flammable vapors, so that, should a leak occur, the likelihood of ignition is reduced. Accepting that there may often be pockets of stagnation in a fire zone and some conditions where effective ventilation flow cannot be provided, a minimum target of five bulk volume air changes per minute, has been accepted as being effective in reducing the formation of a combustible mixture from a leak that does not form a flammable fluid mist. However, it is accepted that this target may not always be achievable during ground operations. Analytically determined ventilation rates should be validated by flight test results e.g. by measuring pressures within each zone and calculating airflow rates using known areas and the differential pressures. Ventilation can also be inferred by analyzing the fire extinguisher concentration dissipation rate measured during fire extinguishing tests, provided that the resulting ventilation rate is corrected for critical flight conditions using validated analytical methods or test data.

6 b.Test: In cases where demonstration by analysis cannot be shown, compliance of compartment sealing and drainage provisions can be substantiated by test. Both ground and flight tests are normally required. As with any FAA/JAA certification test program, the applicant submits a certification plan proposing analysis methods and test conditions, and this plan is approved before the FAA/JAA will conform test articles or witness tests.
A test fluid dispensing system is installed in the airplane with nozzles located to spray into areas where potential leaks would occur. The spray should be dispersed in a manner representative of the potential leakage sources so that any unintended leakage paths will be apparent. Fluid spray bars consisting of a flexible tube with perforations have been used in the past to simulate leakage from flammable fluid lines (such as the engine pylon/strut compartments). The selection of test fluid spray rates and dispersion patterns should be adequate to support the objectives of the testing. Measurement of pressure gradients during flight testing is also sometimes used to validate the drainage capacity analysis in 6.b.(2)(i).

(1) Ground Test. A static ground test should be performed to demonstrate that no hazardous quantities of fluid can be trapped within a fire zone and to make an assessment of the overall suitability of the drainage paths. As a minimum, this test should be performed in a normal ground attitude. However, the effects of other attitudes should be taken into account either by analysis or additional testing. This test has been performed by:

- determining the amount(s) and location(s) where dyed fluid (usually water or a water/glycol mixture) should be introduced to adequately "wet" the area under test and making suitable provisions to do so;
- coating the area under test with a dye exposing substance such as powdered soap or a suitable paint to provide a means to visualise both the adequacy of "wetting" and the drainage characteristics in critical areas;
- introducing the pre-determined measured amount(s) of dyed fluid (Note: typically 1 to 4 U.S. gallons (4 to 15 liters) distributed around each potential leakage source) and measuring the amount of fluid that is recovered from the compartment drains;

- computing the net "undrained" fluid, inspecting the area under test, and making an adequate accounting of the location of all the fluid; then
- establishing that the "undrained" fluid is not a "hazardous quantity".

While there are no simple universally accepted criteria for what constitutes a "hazardous quantity", the following guidance should be taken into account:
- the location of all significant amounts of "undrained" fluid should be identified;
- the drainage paths should not create any significant additional hazard;
- there should be no indication of excessive puddling (Note: individual puddles should be smaller than 1.5 fluid ounces (4.1 cl.));
- the quantity of undrained fluid should be minimized (Note: one measure that has been accepted for reasonably small volumes of test fluids is when over 90 percent of the test fluid is recovered within 10 minutes and there is no practicable means to further reduce the undrained volume); and
- the undrained fluid should not be located such that it substantially contributes to the probability of flammable fluid ignition or the resulting hazard should ignition occur.

This ground test should be completed successfully before flight test demonstration of the drainage system. The system should be dried if necessary after ground test to prevent freezing.

(2) Flight Test.

(i) A flight test should be performed to demonstrate that the intended drainage paths and compartment seals are effective under all anticipated operating conditions, such as those listed in (iv) below, and to show that no fluid migrates to, or impinges on, an area of the airplane where it would create an additional hazard. The flight test should also be used to verify the assumptions in the ventilation analysis. The following test method has been used successfully by applicants in the past.

(ii) The spray nozzle arrangement should be reviewed with the Airworthiness Authority prior to the test flight. Flow rates of one U.S. gallons (4 liters) per minute from each spray nozzle have been used, however, different rates or nozzle arrangements may be required to simulate high pressure leakage patterns and provide coverage of the entire drainage zone. The spray rates need not necessarily match anticipated leakage rates, as the test purpose is to determine acceptable drainage distribution and paths. In fact, excessive spray rates may make the tests less effective due to washing away of the detection compound. The flow rate should be established based on results of the leak source analysis, and the suitability for leak path detection. Where determination of drainage rate is necessary, this can be accomplished by methods such as ground test measurement or analysis corrected for flight test measured differential pressures, or direct in flight observation and correlation of fluid spray injection versus drainage. The actual flow rate and drainage system function should be calibrated prior to the test. If pneumatic bleed is used for pressurization of the test fluid dispensing system, the altitude and flight effects of pressure differentials on the flow rates should be established to assure proper flow rates are achieved. The total volume of dyed fluid sprayed into each zone along with the duration of the test conditions should be used to validate the actual flow rate achieved during the flight test conditions.

(iii) The test fluid should allow testing at anticipated temperatures such that the test fluid will not freeze during the flight test conditions. Different colored dye can be sprayed into each compartment if the various compartments are to be tested simultaneously so that the source of the drained fluid can be identified. A dye exposing substance such as powdered soap or a suitable paint provides a means to visualize the drainage impingement in critical areas. Internal and external surfaces of the airplane where fluid impingement or re-entry are possible should be coated with the dye sensitive material. Flight through visible moisture (including clouds) must be avoided to preclude washing away the soap and the dye drainage pattern.

(iv) Due to the difficulty in predicting complex airflow patterns and the number of different flight test conditions required, numerous flight test conditions are usually required. Test fluid should be sprayed for 30 to 120 second test intervals during all critical flight conditions such as takeoff, climb, cruise, sideslips, turns, descent, approach with gear extended and during the flap transition to the extended position during the dye dump condition, landing with and without reverse engine thrust.

(3) <u>Test Results</u>. The ground and flight tests are normally witnessed by an Airworthiness Authority representative. Photos of the airplane prior to the flight test should be taken to show the dye sensitive coating application. Post-test photos should be taken to document the drainage patterns and to substantiate compliance. Evaluation of drainage test result is often subjective in nature, but drainage of fluid into the following areas is typically considered unacceptable.

(4) Passenger compartment, cargo compartment..

- APU compartment.
- APU exhaust - special design precautions may be required such as a drip fence to guide fuel leakage away from the exhaust nozzle.
- APU inlet - uncontrolled drainage into the inlet may result in inability of the APU fuel control to maintain control of the APU resulting in overspeed.
- Engine inlets or exhaust systems.
- Accessory compartments or areas where nominal ignition sources are expected to exist at the time of the leak, such as the battery compartment, electronics bays, or logo lights.
- Wheel well containing a nominal ignition source.
- Another compartment of the same engine or APU installation.
- A compartment containing an oxygen reservoir.

- Any other area where an ignition source (including those caused by latent or anticipated failures) is expected to exist while exposed to leaked fluid.

Test results may necessitate redesign of fluid drainage systems and therefore testing should be scheduled accordingly. Relocation of drain masts, extension of drain masts, installation of vortex generators on the end of the drain mast, installation of drip fences to deflect flammable fluids away from critical areas, and implementation of revised sealing procedures or modification of seal designs have been required on some airplanes in order to obtain a satisfactory result.

APPENDIX A

Aircraft Flammable Fluid Flammability, Ignition And Fire Characteristics.

A.1 General.

Flammability, ignition, and fire characteristics of aircraft fluids can vary widely depending on the fluid, type of leakage involved and fluid and ambient conditions in the area subject to leakage. This section provides some basic information on these characteristics that should be considered in addressing flammable fluid fire protection. Additional, information is available in the references, although complete information for all fluids or scenarios could require further research or testing.

A.2 Flammability.

A fluid will be flammable when its vapor is mixed with air within a certain range of mixture concentrations. For equilibrium conditions, this will be a function of the fuel and air temperature. Characteristics of typically used aircraft fluids are as follows:

Fluid	Flammability Range		Flash Point at Sea Level	
	Vol. %	Reference	° F	Reference
Fuels				
Aviation Gasoline	1.3-7.1	2.d.(3)	-49	2.d.(3)
JET B, JP-4	1.3-8.2	2.d.(3)	0	2.d.(3)
JET A, JET A-1, JP-8	.6-4.7	2.d.(3)	100 min	Spec.
TS-1			80 min	
Diester Oils				
MIL-L-7808	1.0-12.0	MSDS**	437	2.d.(6)
MIL-L-23699	1.0-12.0	MSDS**	440	2.d.(6)
Petroleum Hydraulic Fluids				
MIL-H-5606			180 min	Spec.
Synthetic Hydrocarbon Hydraulic Fluids				
MIL-H-83282			401 min	Spec.
Mil-H-87257			338 min	Spec.

Phosphate Ester Hydraulic Fluids				
Skydrol 500			360	2.d.(6)
Type IV Class 1			320 min	2.d.(8)
Type IV, Class 2			320 min	2.d.(8)
Type V			300 min	2.d.(8)
Anti-Icing Fluids				
Isopropyl Alcohol	2.0-12.7	MSDS**	53-60	MSDS**
AL5 (TKS Fluid)	2.0-12.7	MSDS**	129-138	MSDS**

*Designation per SAE AS1241C.

**MSDS is Material Safety Data Sheet from one or more fluid suppliers.

Several additional factors related to flammability are as follows:

- Equilibrium mixtures, or mixtures corresponding to laboratory procedures, do not usually exist in aircraft fluid leakage situations.
- The actual lower flammability limit is typically 10-20° F lower than the flash point, since the flash point procedure involves downward flame propagation instead of upward. Fluid at the flash point will not necessarily sustain flame. Some specifications include a fire point that is somewhat higher than the flash point.
- A pressurized spray can be flammable at lower temperature than represented by the flashpoint. An extreme example is starting of an engine at –40 ° F or colder using JET A fuel. The flammability is strongly related to degree of atomization and ignition energy, which can be several orders of magnitude larger than minimum ignition energy.
- A mixture that is non-flammable (too lean) at sea level can become flammable at higher altitude. An example is JET A, for which the lower flammability limit decreases about .8 ° F per 1,000 feet. Similarly, a mixture that is flammable at sea level can become too rich at increased altitude.
- Due to non-uniform mixtures, ventilation may not completely eliminate a flammable condition. If a leak forms a flammable or too rich non-flammable mixture or spray at the source, it is unlikely that ventilation will complete eliminate the flammability although it may reduce the flammable volume further away from the source.

A.3 Ignition Properties.

A.3.1 General.

Ignition of a flammable vapor depends on the mixture concentration, ambient pressure, and the size, duration and temperature of the ignition source. This can range from an extremely small, short duration, high temperature source such as a voltage spark to a large, long duration, lower temperature source such as a large hot surface. Mixtures are most easily ignited when they are at or slightly rich of the ideal stoichiometric mixtures and when they are at higher ambient pressures, such as at sea level instead of at altitude.

A.3.2 Voltage Sparks.

A voltage spark consists of a spark arising from a voltage difference strong enough to jump the gap between two electrical conductors. It is accepted that the minimum ignition energy for hydrocarbon fluids under ideal conditions is approximately .20millijoules, although research indicates that this value is statistical and ignition may only occur on the order of 1 in every 1,000 attempts. Similar data for high flash point synthetic fluids is not readily available, however it is noted that the environmental conditions necessary to obtain ideal mixture conditions would be rather extreme. Energy is given by the ideal formula

$$E=1/2CV^2$$

Where E is Energy (joules); C is Capacitance (farads) and V is Electrical Potential (volts)

In an actual case the presence of inductance and resistance in the circuit makes it difficult to determine the actual energy in the spark gap. In non-ideal conditions, such as near the lean limit, or in a mist, or at high altitude, ignition energy can be as much as three or more orders of magnitude higher (i.e., in the 1-10 joule range). Research, particularly in the fuel system lightning strike field, indicates that electrical ignition sources are much more likely to be the break spark or arc types, discussed below, however, research emphasis has been put on ignition energies for voltage sparks because they are more easily quantified.
While AC25.981-1B describes 200 microjoules as the minimum ignition energy for typical hydrocarbon fuels, it also advises (at least, for fuel tank ignition protection) that the applicant applies an appropriate factor of safety when using this value. In the AC25.981-1B case, a factor of safety of 10 is suggested.

A.3.3 Break Sparks and Arcs.

A break spark consists of continuing current across a gap between two electrical conductors, which were originally in contact with current flowing, such as a switch opening. A simplified formula for the energy is

$$E=1/2\ LI^2$$

Where E is Energy (joules); L is Inductance (henrys) and I is Current (amps).

Although this does not account for duration factors which may be influenced by such parameters as current, voltage, rate and amount of separation. The minimum ignition energies with break sparks are typically two to ten times larger than those for capacitive sparks, although the difference may be less with very fine wires and rapid separations such that heat losses to the conductor surfaces are minimized.

An arc consists of ejection of molten conductor material where the current greatly exceeds the conductor capacity. It is noted that it may be difficult to distinguish between break sparks and arcs in some typical examples, such as shorting the terminals of a battery or a high voltage conductor in contact with a tube, since the elements of limited contact area may produce arcs, while intermittent contact may produce break sparks.

Finally, it is noted that in many, but not all, situations, such as the two examples given above, discussions of minimum ignition energy can be somewhat academic since energy release can be large enough that there is no doubt an ignition source is present.

A.3.4 Friction Sparks.

Friction sparks result from molten metal ejection or localized hot surfaces as a result of severe abrasion or impacts of certain metals or other hard surfaces. Research indicates that aluminum has low friction spark potential but that the potential for ignition of hydrocarbon fluids exists with other common aircraft metals such as titanium, various steel alloys, and magnesium. Ignitions have occurred at bearing pressures as low as 20-50 psi and rubbing speeds below 73 feet per second. The potential for friction sparks in a failure scenario would, of course, vary considerably with the specific design and failure mode characteristics of that scenario.

A.3.5 Autogenous and Hot Surface Ignition.

The phenomenon of ignition by the contact of a flammable mixture with a hot surface is quite complex. The lowest ignition temperatures obtainable are though laboratory testing to various Autogeneous Ignition Temperature (AIT) procedures, in which the fluid sample is introduced in a heated vessel such that the fluid, its vapor, and the surrounding air are all influenced by the vessel temperature, and the conditions inside the vessel vary in a complex time-dependent manner. Ignition delays can be up to 5 minutes, depending on the procedure.

Although AIT tests produce minimum ignition temperatures and can be considered safe, with a suitable margin, the necessary conditions may not exist in realistic aircraft flammable fluid ignition scenarios. The closest scenario would be when the hot surface is a large proportion of the compartment surface and when there is minimum airflow. Much research has been conducted into ignition temperatures for other conditions such as hot manifolds, rods, wires, etc., showing a significant increase in hot surface ignition temperature as the hot surface size decreases.
Hot surface ignition temperatures increase with an increase in compartment airflow, however available data indicate the relationship is not strong.

A maximum surface temperature in a flammable leakage zone of AIT – 50°F is easily accepted by the regulatory authorities as not being an ignition source. Demonstrating that a surface temperature above AIT – 50°F is not an ignition source due to factors such as hot surface geometry, compartment conditions, ventilation rates, flammable fluid leakage rates and specific flammable fluid properties (other than AIT), while technically feasible, is often difficult to validate.

There have been instances where surface temperatures exceeding the AIT – 50°F have been deemed acceptable, when showing that ignition sources have been minimized. In these limited instances, factors such as flight condition, time duration of the elevated temperature, flight deck indication, automatic system response to elevated temperatures, and probability of failure scenario have been given consideration as providing acceptable risk mitigation.

The applicant is encouraged to coordinate acceptable validation methods for surface temperatures in excess of the AIT – 50°F in a flammable leakage zone with regulatory authorities as early in the design process as possible.

A summary of Autogenous Ignition Temperatures (AIT) is as follows:

NOTE: This table also shows Hot Manifold Ignition Temperatures, which may be useful to an applicant in proposing an alternate means of compliance.

Fluid	Minimum AIT In Air-°F				Hot Manifold Ignition Temperature-°F		
	¼ atmosphere	½ atmosphere	1 atmosphere	Reference	Spray	Stream	Reference
Fuels							
Aviation Gasoline	-	1030	825	2.d.(4),(6)			
JET B, JP-4	1060	830	445	2.d.(4),(6)		920-1300	2.d.(6)
JET A, JET A-1, JP-8	1100	865	445	2.d.(4),(6)		900-1200	2.d.(6)
Diester Oils							
MIL-L-7808			735	2.d.(6)	1500	1010-1300	2.d.(6)
MIL-L-23699			775	2.d.(6)	1500	1100	2.d.(6)
Petroleum Hydraulic Fluids	1033	820	437	2.d.(6)		730-960	2.d.(6)
MIL-H-5606			656	2.d.(6)		630-1080	2.d.(6)
Synthetic Hydrocarbon Hydraulic Fluids MIL-H-83282 Mil-H-87257			653 min	Spec.	1250	630-1080	2.d.(6)
Phosphate Ester Hydraulic Fluids			950	2.d.(6)	1500	1440	2.d.(6)
			750 min	2.d.(8)		1300	2.d.(8)

Skydrol 500 Type IV Class 1* Type IV, Class 2* Type V*			900 min 750 min	2.d.(8) 2.d.(8)		1300 1300	2.d.(8) 2.d.(8)
<u>Anti-Icing Fluids</u> Isopropyl Alcohol AL5 (TKS Fluid)			750-810	MSDS**			

*Designation per SAE AS1241C.

**MSDS is Material Safety Data Sheet from one or more fluid suppliers.

A.3.6 <u>Hot Gas Ignition.</u>

Hot gas ignition can occur when jets of hot gas are discharged into a flammable mixture. Available data (Reference 1.d.(8)) indicates significantly higher ignition temperatures than for hot surfaces of comparable size, as follows:

	Ignition Temperature-°F		
Hot Air Jet Dia.-In	**N-Hexane**	**JP-6**	**MIL-L-7808**
1/8	1910	1985	1605
¼	1630	1670	1530
3/8	1450	1500	1410
½	1280	1410	1250
3/4	1210	1290	1210

A.4 <u>Fire Characteristics.</u>

A.4.1 <u>General.</u>

Testing and service experience have shown that fire characteristics associated with leaking flammable fluids can vary depending on the type of leak, type of fluid, and environmental conditions in the affected compartment. Characteristics of various types of fires and resulting considerations are discussed below.

A.4.2 <u>Explosive Ignition.</u>

This can occur when the flammable mixture becomes distributed to some degree of uniformity throughout the compartment prior to ignition. Maximum pressure under worst-case conditions (mixture at or slightly rich of stoichiometric, uniform mixture distribution, absence of a long, narrow or convoluted propagation paths) is about eight times the initial absolute pressure. Explosive ignition can also occur with a flammable mist distributed within a compartment, but peak pressures are likely to be considerably lower.

Explosive ignition is likely to occur with more volatile flashpoint fluids, and is unlikely to occur with high flash point fluids unless the fluid and compartment temperatures are higher than the flashpoint.

It is noted that the ignition source may likely be remote from the leak source, contributing to the build-up of a flammable mixture leading to explosive ignition.

Historically, prevention of explosive ignition has been addressed by compartment ventilation. Ventilation is most effective in this regard for relatively small leak rates of volatile fluids.

A.4.3 Spray Fires.

Spray fires occur when a spray resulting from a small pressurized leak, such as a pinhole, contacts an ignition source. The most important characteristic of spray fire is that ignition can occur at temperatures well below the flashpoint, although at higher ignition energies and surface temperatures than an ideal air / fuel mixture. Ignition is a characteristic of the degree of atomization provided by the pressure and leak source. An extreme example, representing on-purpose design rather than a failure condition, is turbine engine light-off at temperatures as low as -40° F using fuel with a flash point higher than 100° F.

Service experience shows that spray ignition may be particularly liable to occur in the case of a high energy electrical wire chafing against a pressurized fluid tube, since the electrical discharge to the tube is capable of creating both a small spraying leak and an intense ignition source. This can create a potentially hazardous fire in at least some higher flash point fluids, such as MIL-H-83282, although the intensity or completeness of combustion may not be as great as with more flammable fluids.

SAE AS1241C prescribes a spray test for phosphate ester hydraulic fluids, using a flame as the ignition source, which requires that either the fluid will not ignite or will extinguish after an initial flash. This specification only covers a specified range of conditions. Sustained ignition has been observed in fire tests involving higher pressures and finer sprays. Therefore, additional testing may be required if it is necessary to characterize the spray ignitability of phosphate ester hydraulic fluids.

Historically, prevention of spray fires has been accomplished by a combination of isolation of potential leak sources from ignition sources, and/or ensuring the potential ignition sources are not sufficiently energetic to be an actual ignition source for the fluid involved.

A.4.4 Pool Fires.

Pool fires consist of burning at the surface of a pool of flammable fluid, which has collected in the bottom of a compartment. They may also include burning along the leakage stream or drip path between the leak source and the pool.

Pool fires can occur outside the flammable range of the fluid involved, however this condition generally requires a more energetic ignition source, such as an existing flame, capable of raising the temperature of a pool surface, and a slower rate of spread along the pool surface. For example, tests have shown a spread rate of approximately 10 meters/minute for JET A at 80° F compared to a flame spread rate of 220 meters minute for JET B at the same temperature.

Tests have shown that with a remote streaming source exposed to a flame, that pool fires occur readily with fluids of equal or lower flash point than MIL-H-5606, but are much less likely to occur with higher flash point fluids at temperatures well below the flash point.

A.5 Ignition Sources.

The following Table gives examples of nominal and potential ignition sources, which need to be considered, for §25.863 compliance. The list is not to be considered definitive for any airplane type; the actual nominal and potential ignition sources will be determined by the airplane design.

	IGNITION MECHANISM			
IGNITION SOURCE TYPE	Hot surface - Temperature >AIT-50°F	Sparking or arcing	Naked Flame	Hot Fluid (Air)
Nominal Ignition source:	Engine/APU casing. Exhaust ducting. HP bleed duct. Brakes. Electrical equipment. Passenger areas.	Electrical terminals - non-sealed. Electrical equipment. Passenger/cargo areas.	Exhaust gas. Passenger areas.	
Potential ignition source:	Electrical cable - normal insulator. Electrical cable - in conduit. Electrical cable bundle/loom. Bleed duct. Electrical terminals - non-sealed. Electrical terminals - sealed. Firewall. Air cycle machine Electrical equipment. Frictional heating. Passenger/cargo areas.	Electrical cable - normal insulator. Electrical cable - in conduit. Electrical cable bundle/loom. Electrical terminals - non-sealed. Electrical terminals - sealed. Electrical equipment. Frictional sparks. Passenger/cargo areas.	Torching flame. Electrical cable bundle/loom. Electrical equipment. Engine/APU surge. Tailpipe fire. Passenger/cargo areas.	Bleed duct.

Draft, September 29, 1999

#5 J3021

ARAC WG Report Format
For §25.1189 Flammable fluid shut-off means

1 - What is underlying safety issue addressed by the FAR/JAR? [Explain the underlying safety rationale for the requirement. Why does the requirement exist?]

To limit the amount of flammable fluid flowing into the fire zone in the event of fire.

2 - What are the current FAR and JAR standards? [Reproduce the FAR and JAR rules text as indicated below.]

Current FAR text:

FAR 25.1189 Shutoff means

(a) Each engine installation and each fire zone specified in FAR 25.1181 (a)(4) and (5) must have a means to shut off or otherwise prevent hazardous quantities of fuel, oil, de-icer, and other flammable fluids, from flowing into, within, or through any designated fire zone, except that shut-off means are not required for -
(1) Lines, fittings, and components forming an integral part of an engine; and
(2) Oil systems for turbine engine installations in which all components of the system in a designated fire zone, including oil tanks, are fireproof or located in areas not subject to engine fire conditions.
(b) The closing of any fuel shut-off valve for any engine may not make fuel unavailable to the remaining engines.
(c) Operation of any shut-off may not interfere with the later emergency operation of other equipment, such as the means for feathering the propeller.
(d) Each flammable fluid shut-off means and control must be fireproof or must be located and protected so that any fire in a fire zone will not affect its operation.
(e) No hazardous quantity of flammable fluid may drain into any designated fire zone after shut-off.
(f) There must be means to guard against inadvertent operation of the shut-off means and to make it possible for the crew to reopen the shut-off means in flight after it has been closed.
(g) Each tank-to-engine shut-off valve must be located so that the operation of the valve will not be affected by powerplant or engine mount structural failure.
(h) Each shut-off valve must have a means to relieve excessive pressure accumulation unless a means for pressure relief is otherwise provided in the system.

Current JAR text:

JAR 25.1189 Shut-off means

(a) Each engine installation and each fire zone specified in JAR 25.1181 (a)(5) must have a means to shut off or otherwise prevent hazardous quantities of fuel, oil, de-icer, and other flammable fluids, from flowing into, within, or through any designated fire zone, except that shut-off means are not required for -
(1) Lines, fittings, and components forming an integral part of an engine; and
(2) Oil systems in which all components of the system in a designated fire zone, including the oil tanks, are fireproof or located in areas not subject to engine fire conditions.
(b) The closing of any fuel shut-off valve for any engine may not make fuel unavailable to the remaining engines.
(c) Operation of any shut-off means may not interfere with the later emergency operation of other equipment, such as the means for feathering the propeller.

(d) Each flammable fluid shut-off means and control must be fireproof or must be located and protected so that any fire in a fire zone will not affect its operation.
(e) No hazardous quantity of flammable fluid may drain into any designated fire zone after shut-off.
(f) There must be means to guard against inadvertent operation of the shut-off means and to make it possible for the crew to reopen the shut-off means in flight after it has been closed.
(g) Each tank-to-engine shut-off valve must be located so that the operation of the valve will not be affected by powerplant or engine mount structural failure.
(h) Each shut-off valve must have a means to relieve excessive pressure accumulation unless a means for pressure relief is otherwise provided in the system.

3 - What are the differences in the standards and what do these differences result in?: [Explain the differences in the standards, and what these differences result in relative to (as applicable) design features/capability, safety margins, cost, stringency, etc.]

There are no differences that affect the design or compliance.

4 - What, if any, are the differences in the means of compliance? [Provide a brief explanation of any differences in the compliance criteria or methodology, including any differences in either criteria, methodology, or application that result in a difference in stringency between the standards.]

In the past both JAA and FAA allowed some aircraft manufacturers to do without a shut-off valve for hydraulic systems. The regulation allows this due to its provisions for otherwise preventing flow of a hazardous quantity, however, no guidance exists in this context and application of this provision has been inconsistent. The means of compliance for preventing hazardous quantity drainage following shutoff has also been inconsistent due to lack of guidance.

5 – What is the proposed action? [Is the proposed action to harmonize on one of the two standards, a mixture of the two standards, propose a new standard, or to take some other action? Explain what action is being proposed (not the regulatory text, but the underlying rationale) and why that direction was chosen.]

To draft an AC and report to provide criteria where a shut-off means is or is not necessary. This includes defining what "hazardous quantity" means in the context of the rule both in 1189(a) and 1189(e).

6 - What should the harmonized standard be? [Insert the proposed text of the harmonized standard here]

Standard for the rule is already harmonized. Action is only to draft a report and AC.

7 - How does this proposed standard address the underlying safety issue (identified under #1)? [Explain how the proposed standard ensures that the underlying safety issue is taken care of.]

Clarifies what "hazardous quantity" means and defines when a shutoff means is required, and provides guidance to prevent use of a system which may allow a hazardous quantity of fluid..

8 - Relative to the current FAR, does the proposed standard increase, decrease, or maintain the same level of safety? Explain. [Explain how each element of the proposed change to the standards affects the level of safety relative to the current FAR. It is possible that some portions of the proposal may reduce the level of safety even though the proposal as a whole may increase the level of safety.]

It maintains current level of safety for most applications. It increases the level of safety for applications which may be required to install a hydraulic shutoff means where they were not previously required to do so.

9 - Relative to current industry practice, does the proposed standard increase, decrease, or maintain the same level of safety? Explain. [Since industry practice may be different than what is required by the FAR (e.g., general industry practice may be more restrictive), explain how each element of the proposed change to the standards affects the level of safety relative to current industry practice. Explain whether current industry practice is in compliance with the proposed standard.]

It maintains current level of safety for most applications. It increases the level of safety for applications which may be required to install a hydraulic shutoff means where they were not previously required to do so.

10 - What other options have been considered and why were they not selected?: [Explain what other options were considered, and why they were not selected (e.g., cost/benefit, unacceptable decrease in the level of safety, lack of consensus, etc.]

No other options evident at this time..

11 - Who would be affected by the proposed change? [Identify the parties that would be materially affected by the rule change – airplane manufacturers, airplane operators, etc.]

Some aircraft manufacturers.

12 - To ensure harmonization, what current advisory material (e.g., ACJ, AMJ, AC, policy letters) needs to be included in the rule text or preamble? [Does the existing advisory material include substantive requirements that should be contained in the regulation? This may occur because the regulation itself is vague, or if the advisory material is interpreted as providing the only acceptable means of compliance.]

There is no current AC applicable.

13 - Is existing FAA advisory material adequate? If not, what advisory material should be adopted? [Indicate whether the existing advisory material (if any) is adequate. If the current advisory material is not adequate, indicate whether the existing material should be revised, or new material provided. Also, either insert the text of the proposed advisory material here, or summarize the information it will contain, and indicate what form it will be in (e.g., Advisory Circular, policy, Order, etc.)]
[]
None exists. The proposed AC should be adopted (technical information attached).

14 - How does the proposed standard compare to the current ICAO standard? [Indicate whether the proposed standard complies with or does not comply with the applicable ICAO standards (if any)]

No ICAO standard.

15 - Does the proposed standard affect other HWG's? [Indicate whether the proposed standard should be reviewed by other harmonization working groups and why.]

It may affect System & Design HWG, but not to a significant degree.

16 - What is the cost impact of complying with the proposed standard? [Is the overall cost impact likely to be significant, and will the costs be higher or lower? Include any cost savings that would result from complying with one harmonized rule instead of the two existing standards. Explain what items affect the cost of complying with the proposed standard relative to the cost of complying with the current standard.]

Most applications will have no cost. Some applications which may be required to install a hydraulic shutoff means where they were not previously required to do so, may experience a recurring cost estimated to be within the range of $1,000 to $10,000 per aircraft.

17 - Does the HWG want to review the draft NPRM at "Phase 4" prior to publication in the Federal Register?

No, unless substantively changed.

18 – In light of the information provided in this report, does the HWG consider that the "Fast Track" process is appropriate for this rulemaking project, or is the project too complex or controversial for the Fast Track Process. Explain. [A negative answer to this question will prompt the FAA to pull the project out of the Fast Track process and forward the issues to the FAA's Rulemaking Management Council for consideration as a "significant" project.]

The HWG considers that the "Fast Track" process is appropriate.

The technical report is presented in the form of the following draft AC. It is recognized that the scope of this subject is narrow and that the contents may be incorporated in a broader document. Notes in ***bold italics*** are editorial comments only not intended for publication.

TECHNICAL BACKGROUND FOR DRAFT AC

Draft Advisory Circular

U.S. Department
of Transportation
Federal Aviation
Administration

Subject: FLAMMABLE FLUID SHUTOFF MEANS FOR TRANSPORT CATEGORY AIRPLANES

Date: 4/22/99 AC/ACJ No. 25-1189-1
Initiated by: ANM-110

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1. **PURPOSE.** This advisory circular (AC) provides information and guidance concerning a means, but not the only means, of compliance with section 25. 1189 of Part 25 of the Federal Aviation Regulations (FAR) which pertains to the shutoff of flammable fluids for fire zones of Transport Category Airplanes. Accordingly, this material is neither mandatory nor regulatory in nature and does not constitute a regulation. In lieu of following this method, the applicant may elect to establish an alternate method of compliance that is acceptable to the Federal Aviation Administration (FAA) for complying with the requirements of the FAR sections listed below.

2. **SCOPE.** This Advisory Circular provides guidance for a means of showing compliance with regulations applicable to flammable fluid shutoff capability in Transport Category Airplanes. This guidance applies to new designs as well as modifications such as the installation of new engines or APU's or modifications of existing designs that would affect compliance to the requirements for flammable fluid shutoff means to a fire zone.

3. **RELATED FAR SECTIONS.** FAR/JAR § 25.1181, § 25.1182, ,§ 25.1187, § 33.17. ***(Note: For ACJ, also include JAR 25A1189).***

4. OBJECTIVE This advisory material provides guidelines for determining hazardous quantity of flammable fluids:

A. With respect to the requirement FAR/JAR §1189(a) that each fire zone must have a means to shutoff or otherwise prevent hazardous quantities of flammable fluids from flow into, within, or through the fire zone.

B. With respect to the requirement of FAR/JAR §1189 (e) that no hazardous quantity of flammable fluid may drain into any designated fire zone following shutoff.

5. **BACKGROUND.** Guidance is required because of different and sometimes inconsistent interpretation of what hazardous quantity means.

A. Regulatory History The flammable fluid requirements of §25.1189(a),(b),(c), (d), (e), & (f) originated from section 4b.445 of the Civil Aeronautics Manual 4b, December 31, 1953. This section was amended by 25-23. Notice 68-18 proposed amendment of §25.1189 to remove the requirements for shutoff valves in engine oil systems. The proposal to add a new (g),(h), and (i) was discussed as follows: Section 25.1189(a) requires flammable fluid shutoff means. However, the majority of the large turbine-powered transport airplanes have been certificated without a shutoff means for their oil systems. The deviations from the oil shutoff means requirement were permitted on the basis that equivalent safety was otherwise achieved since the oil tanks were close to the engine, the quantities of oil were relatively small, and all components materials were fireproof. The service experience of these airplanes has shown that oil shutoff means are not essential, and the proposal would relax the requirement for oil shutoff means on turbine engine installations. The preamble to Amendment 25-23 discussed the proposal as follows: "Proposed §25.1189 (a)(2) has been changed to make it clear that a shutoff means is not required for oil systems for turbine engine installations in which all external components of the oil system, including the oil tanks, are fireproof. The Notice proposed to add a new §25.1189(g) to require each flammable fluid shutoff valve control to be fireproof or to be located so that exposure to fire will not affect its operation. In response to comments received and consistent with the intent of the Notice, the proposal has been changed to make it clear that it applies only to flammable fluid shutoff means and controls located in a fire zone or that would be affected by a fire in a fire zone. The proposal as revised is adopted as an amendment to current paragraph (d).

This regulation was amended by 25-57. The proposal was discussed **in Notice 80-21** dated November 20, 1980, as follows: "Section 25.1198 is revised to clarify the requirement for shutoff means in terms of the vulnerability of oil system components to engine fire sources, and to ensure that fittings and components are considered along with lines that form an integral part of an engine when determining the need for shutoff means, since they are in the same category when installed. Comments were discussed within the preamble as follows: "One commenter recommends that this rule be cross referenced to Part 33 for clarity sake. The FAA does not consider a cross reference necessary since the emphasis of this section is upon the aircraft manufacturers' responsibility to ensure a fireproof engine installation. Adding the word "installation," however, will provide additional clarification. The proposed regulation is adopted with this change.

Note: Comment received that regulatory history is incomplete. FAA requested to review completeness and necessity for this regulatory history.

B. Service History:

The fire zone fire safety service history of FAR/JAR 25 turbine engine aircraft has been very good, especially considering the potential hazards involved. This is attributed to the multi-faceted fire protection means required by FAR/JAR 25. While it is not generally possible to define the contribution of each individual fire protection means, such as flammable fluid shutoff means, it is noted that the relatively few serious accidents that have occurred often involve initiating events such as engine separation or rotor non-containment, which can potentially negate some fire protection means, and in which flammable fluid shutoff means represent an important, or possibly sole, backup.
Previous incidents have shown that hydraulic system leaks have fueled fires, especially when fluid mist is produced at high pressure due to small (pinhole) leaks. This type of leakage can be of considerable duration, even with a limited quantity of flammable fluid at the source.

6. **DEFINITIONS.**

A. Hazardous Quantity: An amount which could sustain a fire of sufficient severity and duration so as to result in a hazardous condition.

B. Hazardous Condition: Failure Conditions which would reduce the capability of the aeroplane or the ability of the crew to cope with adverse operating conditions to the extent that there would be:

(i) A large reduction in safety margins or functional capabilities;

(ii) Physical distress or higher workload such that the flight crew cannot be relied upon to perform their tasks accurately or completely; or

(iii) Serious or fatal injury to a relatively small number of the occupants, or.

(iv) For the purposes of this AC/ACJ, and specifically with respect to fire zone fires, a hazardous condition is any condition which could breach or exceed the fire zone integrity requirements or structural fireproofness requirements of FAR/JAR 25.

C. Flammable Fluid. Flammable, with respect to a fluid or gas, means susceptible to igniting readily or to exploding. For the purpose of this AC/ACJ igniting readily includes ignition and burning when introduced into an existing flame, and includes fluids such as fuels, hydraulic fluid (including phosphate ester based fluids), oils, and deicing fluids.

7. **COMPLIANCE METHODOLOGY:** The quantity of flammable fluid which is hazardous may vary with fire zone size and design, fluid characteristics, different fire scenarios, and other factors. Since one of these factors is the presence or absence of flammable fluid shutoff means, the requirements of FAR/JAR § 25.1189(a) and 25.1189(e) are discussed separately below.

7.1 Shutoff Means Requirments (FAR/JAR § 25.1189(a))

Compliance with § 25.1189(a) has typically been shown by installation of shutoff means for flammable fluids, except for lines fittings, and components forming an integral part of an engine and/or fireproof oil system components, which are not required to have a shutoff means per FAR/JAR § 25.1189(a)(1) and (a)(2). Flammable fluids that have been considered include fuel supplied to the engine/APU, fuel that may enter the fire zone from engine recirculation systems and hydraulic fluids entering the fire zone. Oil that may be supplied from outside the fire zone, deicing fluid, and other fluids would require similar consideration, however these are not typically incorporated in modern FAR 25 aircraft engine installations.

Although shutoff means are typically incorporated, FAR/JAR § 25.1189(a) allows the option of otherwise preventing flow of hazardous quantities of flammable fluids. A shutoff means is, therefore, not required if no possible scenario will result in the flow of hazardous quantities of flammable fluid. Factors to be considered in determination of whether this compliance means is acceptable include the following:

A. Considerations

1) Leakage rates and characteristics, slow leakage caused by failures such as cracks or pinholes, which may be a spray or mist if the source is under pressure. In the case of massive leakage caused by component failure or fire damage, drainage capabilities may be taken into account.

2) The amount of fluid in the system that is subject to leakage.

3) Combining A.1), and A.2), the range of potential duration of leakage.

4) Scenarios in which the analyzed system leakage is subject to ignition and is the initial fire source.

5) Scenarios in which the initial fire source is a different system, and fire damage to the analyzed system can result in leakage which contributes to the magnitude or duration of the fire.

B. Acceptable Configuration without Shutoff Means

Considering the above factors and service experience of oil systems without shut-off means, it is acceptable to not install a shut-off means for specific systems which contain flammable fluid if the following conditions are met:

1) All components of the analyzed system within the fire zone are fireproof,

and

2) The quantity of fluid which can flow into the fire zone from all sources, except oil systems, for which shutoff is not provided is not greater than the fluid quantity of the engine or APU oil system for an engine or APU fire zone.

and

3) Accomplishment of AFM Emergency Procedures will preclude continuation of a pressurized spray or mist.

The meeting of conditions (1) through (3) are considered acceptable in precluding a hazardous quantity of flammable fluids from flowing into, within or through any designated fire zone.

7.2 Drainage Following Shutoff Requirements (FAR/JAR § 25(1189(e))

Following shutoff, flammable fluid will be contained within the components and plumbing in the fire zone, and usually within plumbing between the firewall and shutoff means, due to other requirements which affect the location of the shutoff means. These include the requirement to protect the shutoff means from a fire zone fire (FAR/JAR § 25.1189(d)), a powerplant or engine mount structural failure (FAR/JAR § 25.1189(g)), and engine rotor failure (FAR/JAR § 25.903(d)(1)).

An analysis is required for each individual flammable fluid system to determine that the total amount is not hazardous. The analysis should consider the aircraft attitudes expected to be encountered during continues flight following shutoff, which may include emergency descent attitudes, but would not be expected to include climb attitudes steeper than those associated with one engine inoperative flight at V_2. If the analyzed system traverses more than one fire zone, each fire zone should be analyzed separately for the maximum fluid volume which can drain into that fire zone. Credit should not be taken for fire extinguishing provisions. The following are alternate criteria for hazardous quantities of flammable fluid for this condition:

A. An volume not exceeding one quart (.95 liter) is not hazardous.

or

B. An amount shown not to be hazardous by analysis considering the factors listed in 7.1.A above. Additional factors relevant to this condition following shutoff are reduction in pressurized spray or mist due to reduction or absence of system pressure, and the possibility of rapid leakage or drainage due to either an initial leak or fire damage of plumbing and components, such as aluminum components or non-metallic hoses, following the required fire resistance period. Hazard assessment of such rapid leakage and drainage may include the effects of airflow ventilation and fire zone drainage.

The analysis may consider fluid volume versus fire zone drainage capability. The fluid leakage into the fire zone is not considered hazardous if the volume released will not aggravate a fire beyond a 15 minute period from the fire initiation.

As a model which provides an acceptable level of safety, and recognizing that the assumptions of the model as well as standard fire exposure models may vary, it may be assumed for the purposes of this AC that for components and plumbing which are fire resistant, fluid release will occur between five and ten minutes after fire initiation. If the substantiation of drainage rate, per the guidance of AC 25.1187, would drain the fluid volume within an additional five minutes, then the fluid quantity can be considered to be non-hazardous without further hazard assessment.

July 18, 2002

t5

J3020

ARAC WG Report
From Powerplant Installation Harmonization Working Group
For §25.863 Flammable Fluid Fire Protection &
§25.1187 Drainage and Ventilation of Fire Zones .

1 - What is underlying safety issue addressed by the FAR/JAR ?

§25.863: Minimization of the probability of ignition of flammable fluid leakage, and minimization of resulting hazards if ignition does occur.

§25.1187: Minimization of fire zone fire hazard by ventilation to prevent accumulation of flammable vapors, drainage of flammable fluid leakage to minimize fire duration, and prevention of the drained fluid from impinging or entering another part of the airplane where it may cause a hazard.

2 - What are the current FAR and JAR standards ?

Current FAR text:

§ 25.863 Flammable Fluid Fire Protection.

(a) In each area where flammable fluids or vapors might escape by leakage of a fluid system, there must be means to minimize the probability of ignition of the fluids and vapors, and the resultant hazards if ignition does occur.

(b) Compliance with paragraph (a) of this section must be shown by analysis or tests, and the following factors must be considered:

(1) Possible sources and paths of fluid leakage, and means of detecting leakage.

(2) Flammability characteristics of fluids, including effects of any combustible or absorbing materials.

(3) Possible ignition sources, including electrical faults, overheating of equipment, and malfunctioning of protective devices.

(4) Means available for controlling or extinguishing a fire, such as stopping flow of fluids, shutting down equipment, fireproof containment, or use of extinguishing agents.

(5) Ability of airplane components that are critical to safety of flight to withstand fire and heat.

(c) If action by the flight crew is required to prevent or counteract a fluid fire (e.g., equipment shutdown or actuation of a fire extinguisher) quick acting means must be provided to alert the crew.

(d) Each area where flammable fluids or vapors might escape by leakage of a fluid system must be identified and defined.

§ 25.1187 Drainage and Ventilation of Fire Zones.

(a) There must be complete drainage of each part of each designated fire zone to minimize the hazards resulting from failure or malfunctioning of any component containing flammable fluids. The drainage means must be-

(1) Effective under conditions expected to prevail when drainage is needed; and

(2) Arranged so that no discharged fluid will cause an additional fire hazard.

(b) Each designated fire zone must be ventilated to prevent the accumulation of flammable vapors.

(c) No ventilation opening may be where it would allow the entry of flammable fluids, vapors, or flame from other zones.

(d) Each ventilation means must be arranged so that no discharged vapors will cause an additional fire hazard.

(e) Unless the extinguishing agent capacity and rate of discharge are based on maximum air flow through a zone, there must be means to allow the crew to shut off sources of forced ventilation to any fire zone except the engine power section of the nacelle and the combustion heater ventilating air ducts.

Current JAR text:

JAR 25.863 Flammable fluid fire protection

(a) In each area where flammable fluids or vapours might escape by leakage of a fluid system, there must be means to minimise the probability of ignition of the fluids and vapours, and the resultant hazards if ignition does occur. (See ACJ 25.863 (a).)

(b) Compliance with sub-paragraph (a) of this paragraph must be shown by analysis or tests, and the following factors must be considered.

(1) Possible sources and paths of fluid leakage, and means of detecting leakage.

(2) Flammability characteristics of fluids, including effects of any combustible or absorbing materials.

(3) Possible ignition sources, including electrical faults, overheating of equipment, and malfunctioning of protective devices.

(4) Means available for controlling or extinguishing a fire, such as stopping flow of fluids, shutting down equipment, fire containment, or use of extinguishing agents.

(5) Ability of aeroplane components that are critical to safety of flight to withstand fire and heat.

(c) If action by the flight crew is required to prevent or counteract a fluid fire (e.g. equipment shutdown or actuation of a fire extinguisher) quick acting means must be provided to alert the crew.

(d) Each area where flammable fluids or vapours might escape by leakage of a fluid system must be identified and defined.

JAR 25.1187 Drainage and ventilation of fire zones

(a) There must be complete drainage of each part of each designated fire zone to minimise the hazards resulting from failure or malfunctioning of any component containing flammable fluids. The drainage means must be--

(1) Effective conditions expected to prevail when drainage is needed; and

(2) Arranged so that no discharge fluid will cause an additional fire hazard.

(b) Each designated fire zone must be ventilated to prevent the accumulation of flammable vapours.

(c) No ventilation opening may be where it would allow the entry of flammable fluids, vapours, or flame from other zones.

(d) Each ventilation means must be arranged so that no discharged vapours will cause an additional fire hazard.

(e) Unless the extinguishing agent capacity and rate of discharge are based on maximum air flow through a zone, there must be a means to allow the crew to shut-off sources of forced ventilation to any fire zone except the engine power section of the nacelle and the combustion heater ventilating air ducts.

3 - What are the differences in the standards and what do these differences result in?:
While there are some differences in spelling and cross referencing, these differences are not significant with respect to effects on design or compliance.

4 - What, if any, are the differences in the means of compliance?
Neither the FAA nor JAA currently have standardized acceptable means of compliance. As a result, there has been inconsistency in the means of compliance accepted by the same authority as well as between the authorities. Some of the more significant areas of inconsistency include:

- Whether or not §25.863 is applied to various airplane zones, particularly the designated fire zones identified in §25.1181 to which other prescriptive fire protection requirements are applied within Subpart E;

- Interpretations of the minimization requirement with respect to an acceptable probability of ignition. In particular whether or not the acceptable probability of ignition is a function of the probability a flammable fluid will be present to be ignited;

- Interpretations as to whether or not any potential latent leak must be assumed to always be present regardless of the probability;

- Interpretations of the minimization requirement with respect to resulting hazards if ignition does occur. Issues include the extent to which ignition must be assumed, as related to the extent of ignition probability minimization, and methodology for minimizing fire hazards in various locations and scenarios;

- The role of ventilation and drainage in contributing to the minimization of both ignition probability and hazards if ignition occurs;

- Flammable fluid fire protection practices have varied within the same airplane as a function of source system (e.g. fuel, brakes, flight controls), area of the airplane (e.g. cargo compartment, engine strut, EE-Bay) or simply the organization/discipline responsible for the source/protection system(s) (e.g. powerplant installations, mechanical systems, electrical systems);

- Compliance by ground test versus flight test, test methodology, and test conditions.

5 – What is the proposed action?

A proposed AC/ACJ25.863 "Flammable Fluid Fire Protection" is attached to this report. This AC should be published to provide more standardized guidance with regard to acceptable means of compliance for §25.863 & §25.1187.

6 - What should the harmonized standard be?

No change to the existing regulations is deemed necessary at this time. See proposed AC/ACJ25.863 attached for harmonized advisory material.

7 - How does this proposed standard address the underlying safety issue (identified under #1)?

The proposed advisory material will help to standardize the acceptable means of compliance with the subject regulation. This will help to assure that the minimum level of safety intended by these regulations is consistently provided.

8 - Relative to the current FAR, does the proposed standard increase, decrease, or maintain the same level of safety? Explain.

This proposal does not change the current standard, but rather is intended to help assure the level of safety intended by that standard is maintained.

9 - Relative to current industry practice, does the proposed standard increase, decrease, or maintain the same level of safety? Explain.

The goal of the proposed advisory material is to present the current best compliance practices. Consequently, this should maintain or increase the existing level of safety provided by the regulations, but not above that originally intended by the regulations.

10 - What other options have been considered and why were they not selected?:

Changes to §25.863 to more clearly indicate what "minimize" means was considered but rejected. Such a regulatory change was considered beyond the scope of the tasking, somewhat unnecessary given the proposed advisory material, and very difficult to accomplish in a reasonable period of time.

11 - Who would be affected by the proposed change?

Primarily aircraft manufacturers, their suppliers and certification authorities.

12 - To ensure harmonization, what current advisory material (e.g., ACJ, AMJ, AC, policy letters) needs to be included in the rule text or preamble?

See answer to question 10.

13 - Is existing FAA advisory material adequate? If not, what advisory material should be adopted?

FAA AC 25.1187-1 (previously published for comment but never officially finally published)) and JAA ACJ 25.863(a) are not adequate, even if enveloped. This lack of adequate guidance led to development of the additional advisory material recommended in the attachment.

14 - How does the proposed standard compare to the current ICAO standard?

No known ICAO standard.

15 - Does the proposed standard affect other HWG's?

Proposed flammable fluid fire protection means may affect the Hydraulic Systems Harmonization Working Group and the Flight Test Harmonization Working Group.

16 - What is the cost impact of complying with the proposed standard?

No impact to those already utilizing adequate compliance practices. The proposed guidance may result in identification of shortcomings in some past practices by some applicants, however overcoming these shortcomings is required to comply with the current rules and hence inherently justified.

17 - Does the HWG want to review the draft NPRM at "Phase 4" prior to publication in the Federal Register?

N/A.

18 – In light of the information provided in this report, does the HWG consider that the "Fast Track" process is appropriate for this rulemaking project, or is the project too complex or controversial for the Fast Track Process. Explain.

The HWG considers that the "Fast Track" process is appropriate. The complexity may be comparable to the uncontained engine failure hazard minimization task.

FAA Action: Placed on the AVS “Do By Other Means” list, dated June 14, 2005.